2005

An investigation of the factors that influence the career aspirations of Year 12 science students

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An Investigation of the Factors that Influence the Career Aspirations of Year 12 Science Students

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2005

M.Ed

An Investigation of the Factors that Influence the Career Aspirations of Year 12 Science Students

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A thesis submitted in partial fulfilment
of the requirements for the award of
Master of Education
at the Faculty of Community Services, Education and Social Science,
Edith Cowan University.

August, 2005

ABSTRACT

What has become apparent in recent years is the lack of upper secondary students choosing science related subjects in their final years of schooling. Even of those students who do choose science subjects to study in Years 11 and 12 in Australia, many tend to choose non-science pathways for tertiary education options (Department of Education, Science and Training, 2003). This is a worrying trend, given the numbers of science professionals and teachers required in the new age of technology.

By investigating a sample of Western Australian Year 12 students that study any science related subject, it is expected that there may be some underlying factors that can be identified that play important roles in their career aspirations. Previous research suggests that these factors will most likely be a combination of social, environmental and individual influences. Science learning experiences, albeit positive or negative, also most certainly determine an individual's interest in science. It is important to understand why science is failing to capture the interest of our best students, who potentially could contribute intellectually to the future of Australian science.

A sample of five secondary metropolitan schools was involved in the collection of data. Using a qualitative case study research method, Year 12 science students, aged 16 to 17 years, were surveyed on aspects of career aspirations and experiences in science. Focus groups from each school participated in a narrative inquiry with the author to further probe their thoughts about career choices in relation to science learning experiences. Staff involved in helping students with their career decisions such as Career Advisors, Year 12 Coordinators and science teachers were also interviewed.

In summary, it can be noted, that whilst many of our Year 12 science students are reported high levels of enjoyment of science, there is significant room for improvement. Teachers are seen as a vital link in fostering students' enjoyment of science, and need to be able to teach science in a relevant fashion, enabling students to understand and to be able to explain the concepts of science. Teachers also have

an important role to play by identifying the range of careers that scientific knowledge will support.

The study found that personal interest and academic ability are significant factors that influence the career aspirations of Year 12 students, it must also be acknowledged that parental influences also have a large influence on career aspirations of Year 12 students, as well as a range of other factors that will be discussed in the body of this research. The choices of university versus TAFE continue to be an issue, with the majority of students opting for university courses even when not academically able to fulfill the course requirements. Career counselors also need to play a more active role in helping Year 12 students with decisions by being more readily accessible with relevant information, as this was one criticism of the Year 12 students that participated in this research.

In conclusion, it is important to note that a greater priority needs to be given to developing the quality of secondary science, and education about career pathways in science. It is very important that all students experience a science education that will make a difference in their lives whilst fostering scientific literacy. It is also important, as a society, to attract our best young minds into science as this will only endeavour to increase the competitiveness of Australian science (Goodrum, Hackling & Rennie, 2001).

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;

(ii) contain any material previously published or written by another person except where due reference is made in the text; or

(iii) contain any defamatory material.

Signed: 

Christina Rose Holly

ACKNOWLEDGEMENTS

I would like to sincerely thank my supervisor, Dr Vaille Dawson for her constant guidance, extensive support, wisdom and assistance in helping me to complete this research and the production of this thesis. Without her encouragement, it may have not been completed and I am really grateful for her belief in me being able to finish this research.

I would also like to acknowledge and thank my husband, Paul Holly, for his support, understanding and encouragement, especially when my enthusiasm flagged in the final stages of writing up the thesis. Thanks must also go to my family and my in-laws who also continually encouraged me throughout my studies.

Finally, I would like to thank the students, teachers and career counselors who gave up much of their own time to assist me in my research. Thanks must also go to the five schools who willingly participated in the study conducted. Without their cooperation, this research would not have been possible.

Christina Holly

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CHAPTER ONE

INTRODUCTION

The purpose of this chapter is to outline the significance of this study in relation to the goals of science education and career aspirations of Year 12 science students. It is important to recognise the role of secondary schools to realise ways in which science career aspirations can be actively encouraged by science teachers and other relevant personnel. This chapter will also outline the purpose of the study, and outline the research questions that will be investigated.

The Background to the Study

The social and economic pressures for students and their parents have contributed to making the area of career education one of primary importance. Schools have a significant contribution to make in preparing young people for adult life and employment. Career education must focus on personal development with schools encouraging students to see themselves as autonomous and responsible members of society. The development of career aspirations can help students clarify their career goals, and thus, make the learning experience more meaningful in secondary schools (Wang & Staver, 2001).

With the current goal of science education being to improve the level of scientific literacy for all students, it is now pertinent to investigate why a large proportion of secondary students are not choosing to complete further studies in science. Although, not all students are destined for science-related careers, they need to be informed of the different possible career pathways in science. It is also important to investigate the impact of classroom experiences in science and to determine if they shape career choices that students will make for post-secondary education. Goodrum, Hackling and Rennie (2001) report:

> Of greatest concern is the increasing gap between student numbers and science enrolments which has increased from 1990 to 1998, and is illustrated by the ratio of students: enrolments. Reversing this trend will require schools to offer secondary science subjects that are inclusive of both males and females, and of the wide range of interests and abilities represented in the population of students attending schools in the post compulsory years (p. 43).

Through my own personal experiences as a science teacher for the last 13 years, and as Year 12 Coordinator in an independent girls' school for six years, it has become apparent that many of our highly academic students do not opt for the variety of career options in science, seeming to veer towards the more generic areas of commerce, business and the humanities. Gender differences have been seen to be apparent, with physical sciences seeming to be more attractive to males than females. This was noted in research conducted between 1980 and 1998 by Goodrum et al (2001). The difference between male and female percentages has been reduced with significant rises in females undertaking Physics and Chemistry in Year 11 and 12. This may be due to the attempt to teach physics in context which may have made it a more inclusive subject (Curriculum Council, 2004). Girls need to continue to be encouraged, in secondary school science, to see science careers as viable and exciting. Many studies (Johnson & Johnson, 1991; Nair & Fisher, 2001; Parker, Rennie & Harding, 1995) have indicated that learning in science classrooms can take on a competitive nature, with boys preferring competition and individualised learning and girls performing better with cooperative models and mutual assistance. The teaching of science has to take these different learning styles into account to continue to make science an interesting subject for both genders.

Science teachers are often ill informed themselves of the variety of new career options in science and the range of future employment choices in science. If secondary science teachers were to become better educated through professional development and liaisons with universities and TAFE (Training and Further Education), we may see a

future generation with a far more enthusiastic interest in the sciences. This, of course, would require professional development of science teaching staff and relevant careers counselors. For this to occur, the secondary education system would have to be able to facilitate this professional education of relevant teaching staff.

The Significance of the Study

Science educators need to become aware of their impact on students, and aim to try and shape students' experiences to be positive and rewarding in science. Thomas (1990) states that most students have chosen their future pathways at the age of 16. The range of factors that shape students' aspirations cannot be underestimated, and these range from individual, social to environmental influences (Patton & McMahon, 1997). With schools playing an important part in shaping career aspirations of secondary students, classroom experiences in science can either enthuse or disinterest our science students. The importance of individual characteristics such as knowledge, age, skills, gender, ability and self concept act to shape future career choices, with family and other societal influences also playing a critical role (Herr & Cramer, 1992).

What will be investigated in this research study is the extent to which students' career aspirations are influenced by experiences in Year 12 science related subjects. It is important to know if this has any significant bearing on students making the decision to continue studying science in their post-secondary education. The importance of engagement in science has long been recognised as an important issue for students to maintain their interest in science. Osborne and Collins (2001) support this:

> Maintaining school science as a vibrant, stimulating and lively subject within schools, in our opinion, is critically dependent on the ability of the education system to recruit and retain competent and confident teachers of science who are justly remunerated for their skills...the failure of school science to engage its pupils will inevitably lead to a greater exacerbation of this problem as fewer and fewer pupils choose to return to a subject that lacked appeal (p. 463).

It is possible that the majority of damage to children's enjoyment in science has already occurred in the lower secondary years of science education (Goodrum et al 2001). This has the disadvantage of disenchanting our students in science, and they either select a course of science for upper secondary education to gain entry into a non-science career, or completely opt out of science. What this study will aim to ascertain is whether the experience of Year 12 science is encouraging students to consider possible career pathways in science.

It is important for secondary schools to realise ways in which science career aspirations can be actively encouraged by science teachers. Yager and Bonnstetter (1984) found that many North American secondary science teachers seldom admit their ignorance about science in their teaching situations, and that generally science classes are seen as less interesting and more uncomfortable, the longer a student stays in school. These findings are echoed in later research, indicating that career aspirations are often influenced by enjoyment of the science teaching experienced by students (Wang & Staver, 2001). Many studies have indicated that students that have positive experiences in science are far more likely to investigate tertiary options in this area (Nair & Fisher, 2001; Wang & Staver, 2001).

This would involve teachers receiving information regarding careers in science and actively promoting these in accordance with the delivery of the science curriculum. The Committee for the Review of Teaching and Education (2003) comment:

> ...too few well qualified, committed and innovative teachers of mathematics, science and technology in schools has led to too few well prepared, confident and interested students entering higher education. Amongst those who do commence, retention is not high (p. 3).

Millar, Osborne and Nott (1998) argued that science teachers need to engage teenage curiosity and interests in future science career pathways by passing on some of the important and exciting knowledge about scientific ideas that can empower them to

express views on, and become involved in issues that permeate daily life. Millar, Osborne and Nott (1998) comment:

> Science education matters because the products of science and technology that permeate our daily lives are an intrinsic part of society's infrastructure. We need train and educate new generations of scientists and technologists to maintain the technological tools and systems we value, and to develop new and better ones to meet new needs and solve new problems. School science is, for the minority of young people, the start of the process that will enable them to become the scientists and technologists of the future (p. 21).

This study will endeavour to add to existing research about how science experiences in schools can influence students' decisions to pursue a career in science. This is an important issue for our society that depends on increasing young peoples' contribution to technology for our future world.

The Purpose of the Study

The purpose of this study is to identify significant social, environmental and individual factors that influence Year 12 Western Australian science students when they choose post-secondary career pathways. As the study is focusing specifically on careers in science, learning experiences will also be investigated to see if there is any relationship between positive experiences in the science classroom, and choosing a career that pertains to a science-related field.

Research Questions

This study will address the following research questions

(1) What experiences are Year 12 students having in their science subjects?

(2) What aspects of science education are likely to influence the career aspirations of Year 12 science students?

(3) What other significant factors influence the career aspirations of Year 12 science students?

Definitions of Terms

For the purpose of this study, it is important to have a working definition of the term 'career aspirations'. It is defined as the desirable career that students would like to pursue post-secondary schooling. Another term described in this study is 'role model' which can be defined as someone whose life and activities influenced the respondent in specific life decisions (Basow & Howe, 1980). Nakua and Kokaly (2001) also explain that role models seem to be other persons who exert some influence, or by simply being admirable in one or many ways.

An Overview of the Research

The purpose of this chapter has been to outline the significance of this research in relation to the goals of science education, and to outline the importance of career aspirations of Year 12 science students. This chapter also outlined the purpose of the study and presented the research questions that were investigated.

Chapter Two will identify the relevant literature that relates to career development during adolescence, learning experiences in the science classroom, the role of science educators and careers in science.

Chapter Three will outline the research methodology that was used to collect data from Year 12 science students and staff to address the research questions of the study. This chapter will outline the conceptual framework of the study, with a detailed description of the sample of the population used for the research. A discussion of the research method employed will be discussed, with emphasis on the methods of data collection and how the data was analysed.

Chapter Four will present the analysis of results collected from the survey administered to 401 Year 12 science students. Further data that has been collected via focus group interviews with the students and staff from the five secondary schools that participated in the survey will also be discussed.

Chapter Five will explore the key findings from the research that was conducted. This chapter will present the assertions of the research and outline the implications that the research has for science education.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

The purpose of this chapter is to identify the relevant literature that relates to career development developed during adolescence, learning experiences in science, the role of science educators and careers in science. The literature discussed will provide information that will provide a conceptual framework for the current research that is being conducted.

Career Development

For most teenage British students studied via a written survey by Thomas (1990) the decision to follow a science path was chosen at 16 years of age. For some science students, the decision was a straightforward one, a matter of following ability and inclination. For others, it was a hard choice and different factors were taken into account. Clearly schools played an important and direct part in the actual choice of the subject, as well as giving educational stimulation. Some students were aware of peer group pressure and pressure from teachers who said that a science qualification led to jobs. For many students the decision to study science came naturally from family interests. A number had come from scientific backgrounds (fathers and/or mothers as engineers, doctors, teachers, lecturers in the sciences) and had often provided an impetus to study science through a discussion at home or help through homework.

An individual's framework for career development has been studied widely, and many theorists have attempted to categorise existing theories (Herr & Cramer, 1992). Herr and Cramer (1992) commented that "in general, the categories depicted are not mutually exclusive or independent, but they attempt to explain differential career behaviour and choices from somewhat different vantage points" (p. 156). Many

authors (Herr & Cramer, 1992; Patton & McMahom, 1997) identify a systems theory framework as being relevant to career development. This presents a framework of an individual's career development showing the complex and interrelated systems under which such development occurs. Super (1990) identifies the individual as the central component in the systems theory framework as a unique person in an individual situation for career development. Patton and McMahon (1997) consider the systems theory framework of career development, which encompasses the individual, the society and the environmental and societal context, noting that all of these contexts play an important role in the development of career choices.

Patton and McMahon (1997) create a model representing the individual which also contains the range of intrapersonal influences on career development. This would include influences such as personal values (Brown, 1996) and interests (Holland, 1985) which are seen as important in career development. Patton and McMahon (1997) also note the importance of health, beliefs, personality, knowledge, age, skills, self-concept, gender and ability as other very influential personal influences. Many of the major psychological theories of career development are based on the assumption that individuals will seek to maximise a relationship between their self-concept and the type of work they choose (Brown, 1996; Holland, 1985). Buchanan (2002) found that career aspirations in adolescents have consistently been associated with high socioeconomic status, internal locus of control, self-esteem, high education aspirations and academic achievement.

The individual's social environment is also comprised of many primary social groups to which the individual belongs. These social groups include such things as peers, family, media, community groups, employers and the school or workplace (Patton & McMahon, 1997). As Gottfredson (1996) suggests, each of these social groups holds beliefs, values and attitudes that may be conveyed to the individual in a number of ways. Santos and Coimbra (2000) note the fundamental influence of families in career development and although they do not necessarily attempt to influence their children's personal occupational choice, they are often very active agents in influencing their children in selecting the broad range of career options (Young & Friesen, 1992).

Ketterson and Blustein (1997) observed that secure attachment relationships with parents are associated with greater self exploration as well as an increase in non-traditional exploration of career pathways.

The environment and the wider society will also influence the individual. It has been noted that socioeconomic influences can affect the values held, the education received, the role models observed and the information about careers given (Roberts, 1977).

The influences that are elaborated in the discussion of a systems framework are representative of the multitude of influences on career development, and it is important to also note that reciprocal interactions will constantly occur between the influences. Patton and McMahon (1997) cite:

> ...as the nature of the influences change, so too does the degree of influence. Dynamic reciprocal processes occur whereby a change to one part of the system brings about change in all other parts of the system through a mechanism of feedback loops (p. 2).

In particular, the influence of role models on career development has been well documented (Hackett & Betz, 1981; Bandura, 1986). Through such studies, it has been suggested that people learn how to make career decisions and engage in career behaviours by observing others. Contextual factors, such as barriers and supports can affect occupational outcomes indirectly through their influence on interests and outcome expectations (Lent et al., 1994). Evans and Whigham (1995) found that classroom interventions using relevant career role models can increase students' non-traditional occupational choices, increasing the favourability of attitudes towards science, mathematics and engineering careers. Role models are also perceived as very important as they can facilitate academic and career development through their support and guidance, as well as providing modeling and inspiration (Nauta & Kokaly, 2001).

The acceptance that career development is a phenomenon that occurs over a lifespan is noted by many authors (Gysbers, 1987; Herr & Cramer, 1992; Super, 1990; Patton & McMahon, 1997). The systems theory framework supports the notion that career development will not always be linear or straightforward, but can be in constant flux and may often change over time. Patton and McMahon (1997) note that "future considerations, such as anticipated lifestyle and employment market trends, may also influence the career development of an individual" (p. 26).

Wyn (2001) acknowledges that young people in the future will know no world other than that in which employment is precarious, and that education is a life-long process. To be enterprising is going to be an essential skill to adapt to the changing environment of today's workforce. The complexity of career development needs to be largely dealt with using a constructivist approach, as individuals will eventually construct their own reality that has been impacted by a range of influences.

Gender Differences

Schools remain a critical link in the social processes leading to the existing gender divisions that occur in the workforce. Rosemary Deem (1978) states "education does not create the sexual division of labour, nor the kinds of work available in the labour market, not the class relationships of society, but it rarely does anything to undermine them" (p. 38). Traditionally, vocational education has consisted of matching students to a variety of positions in the workplace and industry. Many of these areas remain to be heavily stereotyped with certain occupations remaining targeted at females, and others left for males.

There is also a common assumption that sciences are more difficult than the humanities and that physics is more difficult than chemistry which is more difficult than biology. There is an enormous divide between the humanities and the sciences. Osborne and Collins (2001) found in their study that girls made many more negative comments about physics than boys which would suggest that school physics lacks some appeal for girls.

Studies have also shown that there is a difference in classroom environment perceptions between boys and girls (Burkam, Lee & Smerdon, 1997). Female students' perceptions seemed to deteriorate as they entered high school science classes (Ferguson & Fraser, 1996) with boys preferring individualised and competitive learning and females preferring learning involving cooperative models and mutual assistance (Parker, Rennie & Harding, 1995). Sjoberg (1989) also found that between two and three times as many boys as girls choose mathematics and physics with girls more readily choosing biology and chemistry.

Findings by Osborne, Driver and Simon (1998) also found that boys' participation in physical sciences post-Year 10 still far outweighs girls' participation.

> Many had hoped that the introduction of balanced and compulsory science to age 16 would overcome the problems associated with choice at 14, a critical age when adolescents seek to establish their self-identity, which is strongly related to subject and career choice. Clearly, for the physical sciences, balanced science has failed to meet these expectations...the majority of girls are not choosing to study physical science, indicating either that they still hold some inner deep-seated antipathy to physical science, or, alternatively, that girls see more positive life choices in other subjects (p.30).

Working from a perspective of the systems theory framework as discussed by Patton and McMahon (1997), schools can assist female students to focus on the effects and implications of barriers evident in stereotyping, and help to restore educational, career and life options. Career counselors, educators and schools need to encourage their female students to acknowledge the "multiplicity of interrelated factors which impinge on each individual's career development" (Patton & McMahon, 1997, p. 42) and to realise the full potential of females in previously male dominated fields.

Learning Experiences in Science

It should be a fundamental aim of all science educators to instill a wonder and excitement about learning science. In previous years, the curriculum has been so overloaded with content, that it is not surprising that students are becoming disinterested in pursuing careers in science. Content is over emphasised, both in the curriculum and assessment, and this often leads to a very rigid mode of teaching (Miller, Osborne & Nott, 1998). Osborne and Collins (2001), in their studies of 144 16-year-old students in the United Kingdom, also found that many of these students felt that science lacked imagination and creativity and that it was more about your ability to learn the content delivered. With the new push to reduce content in the Western Australian science curriculum through the implemented *Curriculum Framework* model (Curriculum Council of Western Australia, 1998), it is hoped that students and teachers will be able to see more clearly the role of science in everyday life, and its relevance to society. The Curriculum Council of Western Australia (1998) felt that science education should empower students to be questioning, critical and reflective thinkers. In an ideal teaching environment, the Curriculum Council (1998) note:

> Science education develops students' confidence to initiate and manage change to meet personal, vocational and societal needs. Science education assists students to be active citizens by providing the understandings they need to be informed contributors to debates about sensitive, moral, ethical and environmental issues (p. 219).

Millar, Osborne and Nott (1998) stress that one of the primary reasons for effective science teaching is to convey the important and exciting knowledge about the material world to our students. An effective understanding of scientific ideas will help young people in their personal decision making and empower them with the confidence to express their own views about issues in the public arena.

Osborne, Driver and Simon (1998) have been very concerned about the decline in the numbers of students studying science, especially in the light of society's increasing need for a strongly scientific literate population. They found that there was a clear disparity between 18-year-old students' and teachers' notions of science in the United Kingdom. Students' images of science seem to have remained unchanged with them still naming famous scientists as Einstein, Newton and Bell, and not even mentioning the more contemporary role models. Osborne and Collins (2001) suggest that school science has tended to offer little for those creative pupils who require self-expression. Whilst there are countless opportunities to undertake role plays, group presentations or other activities, science essentially deals with established knowledge and is often delivered in such a way that students are not actively engaged, or are not encouraged to have ownership of their own learning. Goodrum, Rennie and Hackling (2001) carried out an extensive research project on the status and quality of teaching and learning science in Australian schools finding that:

> When students move to secondary schools many experience disappointment, and it is here that students' interests wane markedly. Science at school is engaging and challenging when it connects with students' contemporary interests and experiences, but often this was not the case (p. 166).

Goodrum et al (2001) also found that there is a concern that the type of science being taught and the learning outcomes being achieved are not those that will adequately prepare students for the future world in which they will be living and working. The disturbing findings state:

> For the majority of lower secondary students, the science they are taught lacks relevance to their needs and interests, and fails to develop key aspects of scientific literacy. Only about one-fifth of lower secondary students report that science lessons are relevant or useful to them, very often or almost always. About one-third of these students indicate that science never deals with things they are concerned about or helps them

> make decisions about their health, which raises questions about the appropriateness of the selected content and learning contexts (p. 153).

Woolnough (1994) outlines the importance of effective science teaching as a major determinant of British students' attitudes towards science. Through his research, he found that good teaching was characterised by teachers being enthusiastic about their subject, setting it in everyday contexts and running well-ordered and stimulating science lessons. Good teachers were also sympathetic and willing to spend time, both in and out of lessons, talking to students about science, careers and individual problems. Woolnough's findings support the idea that effective science teaching is a formative influence on students' attitudes towards science (Osborne, Driver & Simon, 1998). Gallagher (1994), in his studies of American schools, also supports this as he found that students' perceptions of their teachers' attitudes toward teaching science and toward individual students are predictors of student decisions to persist in science. Eichinger (1997) carried out a study of successful college science students' perceptions of secondary school science in the United States, with the primary goal of identifying influential variables as perceived by a sample of successful high-ability science students. He found that of all the variables examined, the quality of the student-teacher interaction, particularly for science resistant students, exerts the greatest impact on student attitudes.

Goodrum et al (2001) noted the importance of teachers as the basis for educational innovation, reform and improvement and emphasised that the teacher is the most important factor for improved learning in science. Goodrum et al (2001) state:

> Efforts to close the gap must focus on helping teachers recognise the gap between students' real needs in science and what is offered in the actual curriculum. Teachers also need support to develop the understandings and skills needed to make the change possible... Research has continually shown that imposed change without teacher engagement and ownership of the change brings little effective improvement in the long term (p. 169).

Eichinger (1997) notes that "...our progress as science educators may depend on paying careful attention to student voices at both the individual and collective levels" (p. 129). Although Osborne and Collins (2001) carried out a study with little focus on teachers, it was apparent that students in all groups identified approaches adopted by teachers that increased their interest in aspects of science. It was also found that girls especially "...highlighted the importance of building a rapport or relationship between pupils and teachers that developed through opportunities to raise questions and discuss aspects of science" (p. 459).

Osborne, Driver and Simon (1998) conclude their research findings with a pertinent question:

> It must be asked whether we teach too much science of the wrong kind for too long. The menu of a seven-course meal of an education in science may look enticing, the first course may be enchanting, the second a delight and the third satiating, but the fourth? And as for the fifth, sixth and seventh...? Before we ask more young people to dine at our restaurant of science should we not ask ourselves whether the menu we offer is both appropriate nourishment and appealing? (p. 33).

Careers in Science

It has become increasingly important that science is not seen as an area that is remote from people's needs and deeds. Future jobs should be shown in a real societal context (Sjoberg, 1989). For example, students need to be shown, through classroom experiences, that scientists (e.g. engineers, technicians, doctors) work with people and are concerned with problems of relevance in society. Sjoberg (1989) also comments that students are exposed to the "all too frequent textbook image of science as an objective, disinterested and purely intellectual pursuit of objective truth"(p. 37). What also is worrying is that many science teachers themselves see their job in science as not desirable, and thus, may discourage students from seeking careers in teaching

science. Ingvarson and Loughran (1997) interviewed Australian teachers regarding their perceptions of the status of teaching and found that for most of those interviewed, "having a career meant a promotion out of teaching...they felt the general attitude in the community towards teaching was one of lack of respect and its status low" (p. 14). One specific teacher stated "...I wouldn't even tell them to be a science teacher...they can make a hell of a lot more money doing something else, that's for sure" (p. 16). It is not surprising that students are not developing a love of science if teachers themselves are ambivalent about their role.

Osborne and Collins (2001) uncovered some interesting views from science students in the United Kingdom. They found that "...most groups felt that the value of science was less apparent than English and mathematics, and many of the pupils felt that there were a large number of employment options for which science was unnecessary" (p. 447). Commenting that science has a marketing problem, Osborne and Collins (2001) note that:

> ...science teachers should endeavour to make clear the wide range of occupations which scientific knowledge supports, how it might be used and why it is useful. Whilst there would appear to be a growing awareness amongst some pupils of the general career of science, the lack of specific examples raised implies that little has been done to emphasise the value of science qualifications in a wide range of occupations (p. 447).

The Committee for the Review of Teaching and Teacher Education (2003) comment that the lack of well qualified, committed and innovative teachers of science in Australia has led to few well prepared, confident and interested students entering higher education in this area. Student enrolment still includes a core group of students that are passionate about science, but there are many that are there just to meet prerequisite requirements to keep options open or to improve tertiary scores.
The Committee for the Review of Teaching and Teacher Education (2003) note that:

> ...there appears to be limited efforts to place classroom science in a real world context to make it relevant to everyday life. There is continuing evidence of declining science participation rates among school children, and there appears to be no integration of any of this activity with sensible and realistic careers and course information (p.3).

Conclusion

From the range of literature reviewed, it becomes apparent that there are a range of variables that affect the ongoing participation of students in science. The theory of career development is an integral foundation for occupational choices, taking into account the many extraneous variables that further influence career choices, such as personal experience and interest, role models experienced, social and environmental contexts.

Learning experiences in secondary science seem to be of paramount importance in the maintenance of students' personal interest in science, and thus is an area that certainly requires the attention of secondary educators and educational institutions. The Committee for the Review of Teaching and Teacher Education (2003) venture to state that "...were school science designed to enthuse, inspire and equip students in and for their present lives, more would elect to continue their involvement"(p.14). There is a growing awareness, demonstrated in the literature reviewed, that there is a need to encourage students to aspire to see science as worthy destinations for post-secondary education. Goodrum et al (2001) conclude:

> There should be no conflict between the preparation of future scientists and the science education of all young people. In making science more relevant for young people it is reasonable to assume that it will also become more interesting for those who wish to pursue a career in science. It might be expected that more students would consider a science or technological career as a result of exciting and interesting science studies at school (p. 2)

CHAPTER THREE

METHODOLOGY

Introduction

The purpose of this chapter is to outline the research methodology that was used to collect data from Year 12 science students and staff to address the research questions of the study. The first section will outline the conceptual framework of the study, followed by a detailed description of the sample of the population used for the research. The research design will then be discussed, with emphasis on the methods of data collection and how the data has been analysed qualitatively and quantitatively to produce the results that will be presented in the following chapter.

The Conceptual Framework of the Study

In seeing how science experiences are interrelated to future career aspirations, the focus is on the individual Year 12 student as a central component with other potential influences also identified such as environmental and societal influences, individual characteristics and the social environment to which they are exposed to. This can be best demonstrated by a flow chart to simply demonstrate the relationships that will be investigated in the course of this research.

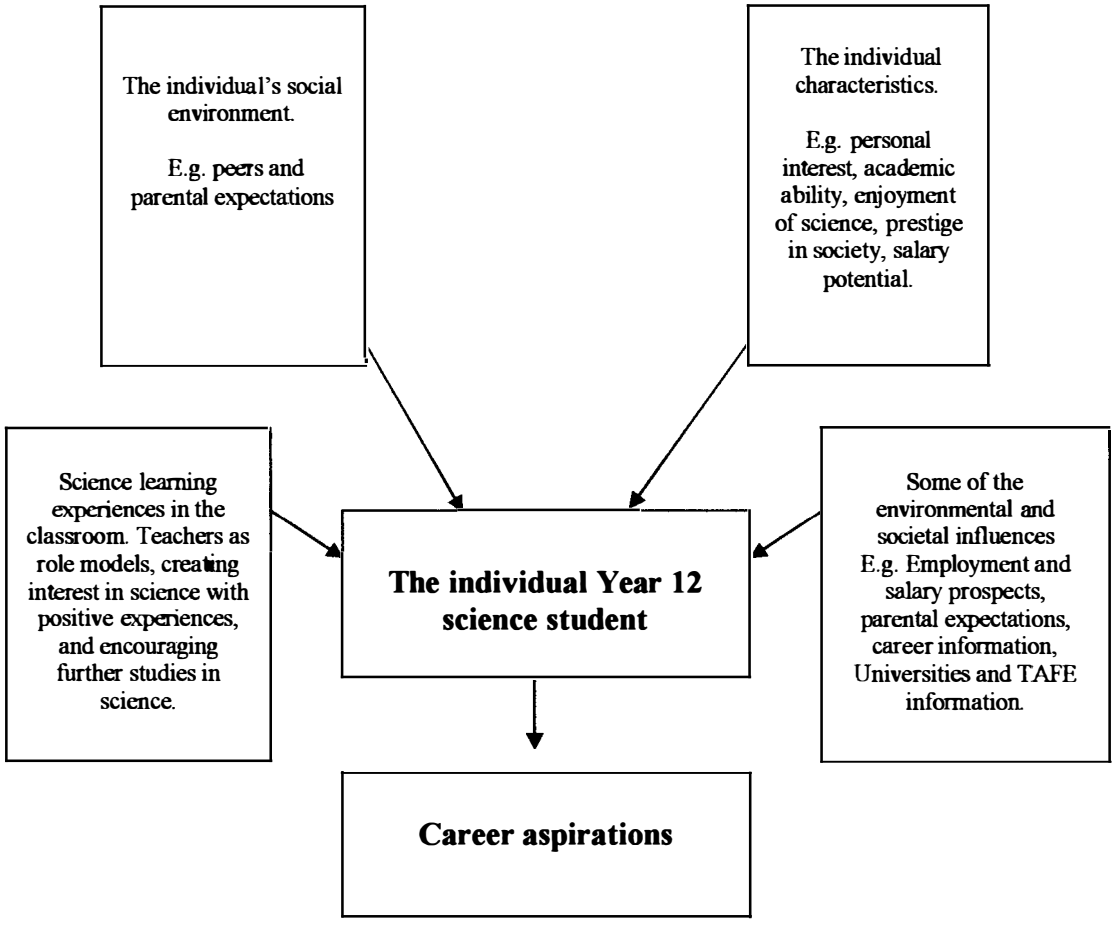

Figure 1: Conceptual Framework for career development of Year 12 Science Students

Research Design

The study that was undertaken is primarily a qualitative research project with an exploratory and descriptive focus. The outcome of this research will be a deeper understanding of the factors affecting career aspirations of the participants selected for the study (Maykut & Morehouse, 1994). The methods of research included a written survey distributed to Year 12 students, and some structured interviews with students, staff and other relevant school personnel from each secondary school that participated in the research.

The results were collected and analysed within an interpretative case study approach, as it involved a study of individual Year 12 science students in their school environment, aiming to gain an in-depth understanding replete with meaning for the subject, focusing on process rather than outcome (Burns, 2000). It is hoped, by using this method, it has allowed the research to retain the holistic and meaningful characteristics of real life events. Burns (2000) also notes that case studies can often assume that the case is representative in at least some ways to others and that it can provide insight into the class of events from which the case is drawn. By probing deeply and analysing intensively, it may provide anecdotal evidence to illustrate more general findings, or it may refute universal generalisation. This suggests that a single case can contribute significantly to theory building and assist in refocusing future investigational direction. Cohen, Manion and Morrison (2000) comment on the interpretive nature of case studies:

> Investigators work directly with experience and understanding to build their theory on them. The data thus yielded will be glossed with the meanings and purpose of those people who are their source. Further, the theory so generated must make sense to those to whom it applies....Thus theory becomes sets of meanings which yield insight and understanding of people's behaviour. These theories are likely to be as diverse as the sets of human meanings and understandings that they are to explain (p. 23)

A useful way of collecting data as part of the interpretive case study approach for qualitative research are in-depth interviews and group interviews (Maykut & Morehouse, 1994). By beginning with individuals, and setting out to understand their own interpretations of the world around them, theory will begin to emerge and arise from particular situations. (Cohen & Manion, 2000).

Through using a survey instrument (see Appendix A for a copy of the survey), focus group narrative inquiries with small groups and interviews with relevant teachers, there should be adequate information collected to draw some relevant conclusions that may contribute to research in the area of career aspirations.

Surveys have the capacity to measure facts, attitudes or behaviour through questions. The survey instrument used in this research aimed to remove as much bias from the research process as possible and produce results that were replicable by using the same methods. Thus, the survey instrument used in the research had to be standardised in terms of how the questionnaire was designed, administered and analysed (May, 2001). To further achieve this aim, after a pilot study of the survey with Year 12 students, one item was reworded in order to allow students to interpret the item more accurately.

The focus group interview data obtained from student and staff interviews produced a wealth of qualitative data about student and teacher perceptions of science in the classroom and the relevant career pathways available in the areas of science. Burns (2000) points out "...that interviews are essential as case studies are about people and their activities. These need to be reported and interpreted through the eyes of interviewees who provide important insights and identify other sources of evidence" (p. 467). The interviews were relatively open-ended, so the respondent tended to act as more of an informant, and the researcher collected from many students as not to become too dependent on only one source.

May (2001) talks of focus groups as being a valuable means for participants to talk to one another, in the presence of the researcher. May (2000) cites "...a balance needs to

be struck between the group being too small for interactive study or too large thus preventing all group members from participating in the discussion" (p. 125). It was found that useful data was generated from the groups of students that had the opportunity to explore some of their views of science in the classroom, and the impact that it had on their career aspirations. For this research, the focus groups for students were in groups of three, unless this was not possible which did occur with School III.

To improve the internal validity of the research and to add rigor, the researcher has employed triangulation which is using two or more methods of data collection in the study to be completed. Burns (2001) cites:

> By analogy, triangular techniques in the social sciences attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint and/or by using a variety of methods, even combining qualitative and quantitative methods in some cases (p. 419).

The data generated by different techniques allowed triangulation and cross checking of emergent hypotheses. Credible reporting of the views of the sample group was ensured by carrying out focus group interviews as well as the students participating in the survey. By speaking to groups of students, the researcher had an increased opportunity to become aware of views that the students did carry in regards to career paths in science (Guba & Lincoln, 1994).

The limitations of interviews alone has long been recognised (Burns, 2000; Cohen, Manion & Morrison, 2000), as there are many sources of bias. Cohen and Manion (1994) note:

> The sources of bias are the characteristics of the interviewer, the characteristics of the respondent, and the substantive content of the questions. More particularly, these will include: the attitudes and opinions of the interviewer; a tendency for the interviewer to see the

> respondent in her own image; a tendency for the interviewer to seek answers to support her preconceived notions; misperceptions on the part of the interviewer of what the respondent is saying; and misunderstandings on the part of the respondent on what is being asked (p. 282).

The main purpose of using interviews is that in an interpersonal encounter, people are far more likely to disclose aspects of themselves, their thoughts, opinions and feelings than they would in a less personal situation. Thus, triangular techniques are more suitable in order to obtain a more holistic view of the outcomes of the research. By interviewing a range of teachers involved with Year 12 students and a written survey, there will be a greater confidence in the findings if they correlate to some degree. Cohen et al (2000) support this by noting that the researcher will be more confident of their findings if the observations of the phenomena match the outcomes of a questionnaire survey.

Triangulation will contribute to the credibility and trustworthiness of the study, and the quantitative data collected from the written survey will be useful in order to validate some of the qualitative data collected from the focus group interviews with students and staff.

Sample

Five secondary metropolitan schools were selected by purposive sampling that was carried out to include a sample on the basis of the researcher's personal judgement of their typicality to address the research questions (Bouma, 2000; Cohen et al, 2000). The schools were comprised of three government co-educational secondary schools, one independent single-sex female school, and one independent single-sex male school. The schools were selected to supply a breadth of secondary student responses and attitudes from a range of socioeconomic groups.

In every research project, there is bound to be limitations that constrain the research findings. Conclusions will be limited to the purposive sample selected, thus creating a narrower interpretation of conclusions. By drawing a sample of students from five schools, it is expected that this will allow a range of information to be collected from students of different backgrounds, and hopefully allow the full range of influences on career aspirations to be discussed. Burns (2000) supports that there is no guarantee that a case is representative of some population, and therefore no validity in generalisation. Therefore, realistically, there can be no expectation that the results collected from such a sample can be generalised to all Year 12 students, as this research is interpreting the perceptions of these students in relation to their science learning experiences, and their interest in further careers in science. It is expected that the findings will be useful for science educators, career counselors and the relevant students who are making the career choices.

A brief description of each of the participating secondary schools is outlined below. Please note that not all Year 12 science students from each school were surveyed, as the participation was largely dependent upon the Heads of Science administrating the survey to all students possible. At some schools, poor participation, much lower than expected, was recorded. This was unavoidable, as the researcher was largely dependent upon the Heads of Science or Deputy Principals for the distribution of the survey. The sample was biased to a larger majority of high achieving students, and therefore the sample is not able to be a representative sample of the wider population, but will remain as useful research based on these particular students.

School I

School I is a co-educational government secondary high school with a total of 487 students from Years 8-12, including 117 Year 12 students in 2003 of which 22 (9 males and 13 females) science students were surveyed. This number did not include all of the Year 12 students participating in science from this school. School I caters for students from low to middle socioeconomic backgrounds with the majority of students aiming for TAFE entry after secondary graduation.

School II

School II is an independent single-sex boys' school with a total of 1204 students from K-12, including 146 Year 12 students in 2003 of which 56 science male students were surveyed. These were not all the Year 12 science students from this school. School II primarily has students from middle to high socioeconomic backgrounds with the majority of students aiming for university entry after secondary graduation.

School III

School III is an independent single-sex girls' school, with a total of 950 students in 2003 from K-12, including 153 Year 12 students of which 114 female science students were surveyed. This was the majority of the students that participated in Year 12 science at this school. School III caters for students from medium to high socioeconomic backgrounds with the majority of students aiming for university entry after secondary graduation.

School IV

School IV is a co-educational government secondary high school with a total of 1200 students from Years 8-12, including 205 Year 12 students in 2003 of which 62 (25 males and 37 females) students were surveyed. These were not all the Year 12 science students from this school. School IV caters for students across a range of socioeconomic backgrounds with the majority of students aiming for university entry after secondary graduation.

School V

School V is a co-educational government secondary high school with a total of 1364 students from Years 8-12, including 245 Year 12 students in 2003 of which 147 (64 males and 83 females) students were surveyed. This was the majority of Year 12 science students at this school. School V caters for students from middle to high socioeconomic backgrounds with the majority of Year 12 students aiming for university entry after their secondary graduation.

Data Collection

The student survey

A well planned and carefully constructed survey instrument is vital to a successful study, and will have the advantage of being able to greatly facilitate the summation and collection of the essential data (Burns, 2000). Before distribution, the survey was piloted by 20 students at an independent girls' school. This was a small scale trial of the proposed procedure, with the aim of detecting any problems so that they could be remedied before the larger study was carried out (Fraenkel & Wallen, 1993).

This survey was designed to be able to analysed quantitatively using SPSS to allow comparisons between schools, and to elicit the factors that were most influential on student choices for career choice. With a survey instrument, it is often difficult to get a high response rate. This was addressed by conducting the surveys with students during class time as negotiated with the secondary schools that participated in the survey. The survey took approximately 10 minutes to complete. The surveys were most often collected in the same lesson to avoid low response rates, and were administered by classroom teachers.

Before commencement of the research, ethics approval was sought from the University's Ethics Committee as the research involved interviews with students and teachers that were to be recorded and transcribed, hence permission needed to be gained from parents and teachers through a consent form. When distributed, each survey had a statement of disclosure attached to comply with ethics standards set by the Ethics Committee (see Appendix B for a copy of the consent form and statement of disclosure).

Before distribution, the Principal from each school was contacted by letter explaining the purpose of the research. A letter was also sent to the Head of Science of each respective secondary school, as these were the teachers that the researcher would

mainly be liaising with (see Appendix C for a copy of both letters). Upon permission being granted by the Principal, the survey was distributed to students by the Heads of Science in each secondary school with the desire to survey all Year 12 science students, or as many of the cohort as possible.

Year 12 students who were currently completing a secondary science subject at Year 12 level participated in the survey distributed. In total, 401 Year 12 students participated in the written survey. The written survey was designed to identify significant social, environmental and individual factors that their career aspirations. The purpose of the survey was to determine the perceptions held by Year 12 students in relation to their experiences of science in the classroom, their career aspirations and the factors that may have influenced their decisions for post-secondary education. The survey was completed by students after they had completed their university and/or TAFE course selection forms, so it is assumed that they have made some decision about what they will be doing post-secondary schooling. Tertiary Institutions Service Centre (TISC) and TAFE forms allow students to select their chosen post-secondary schooling options for universities and TAFE Colleges respectively. Students that participated in the survey studied one or a combination of the university entrance subjects of Physics, Chemistry, Biology, Human Biology and/or the non-university entrance subject, Senior Science.

The survey was distributed to the students and completed during the month of August. By this time, students would have completed approximately 80% of their course work in their subject areas, and were also about to select their post-secondary options. The selection sheets for university and TAFE were due in early September.

The survey comprised three sections, each to address the research questions. Upon identifying themselves by gender, and subjects chosen, students were asked to answer questions about their experiences in each of the Year 12 science subjects that they were studying. For the small number of students that were studying three science subjects, they completed the survey for their two subjects of preference. Students were asked to rate their experiences of science in terms of classroom and learning

experiences, and if they felt that they were interested or encouraged to further their career aspirations in science by either their teacher or from their own personal interest.

In the second section, students were also asked to nominate their chosen field of study for post-secondary schooling. These courses were coded into university science or non-science courses, TAFE science or non-science courses, apprenticeships, defence force careers or no career path noted. The researcher was mainly trying to ascertain whether students were opting for any further education involving science.

The third section of the survey asked the students to identify the degree to which a series of factors had influenced them in their post-secondary options. These factors included:

- parental expectations
- peers
- academic experience
- personal interest
- prestige in society
- media
- school experiences
- university and TAFE information
- teacher role models and expectations
- employment opportunities

The survey had two open-ended questions for students to have the opportunity to give any other responses. The first question asked students if their science experiences have influenced their career options, and the second question allowed the students to identify any other relevant factors that have also influenced them in their career aspirations. Both sets of responses were collated by student and school number, and coded to identify relevant themes that arise from the data collected. This allowed the researcher to have qualitative data that could provide support to any assertions made from the research.

The student interviews

Six students participated in a narrative inquiry from each secondary school to identify their thoughts about their science experiences and the impact that this has had on their relevant career choices for post-secondary options. For four of the schools participating in the research, the focus groups were divided into two groups of three students. School II was limited to interviews with just one student at a time, as the teacher organising the interviews had planned it in this way.

The focus groups of students that were interviewed relied on opportunistic sampling as the interviews were carried out with conveniently accessible groups. This method of sampling is acceptable for exploratory studies, but it limits its ability to be generalised to any wider population (Bell, 1999; Burns, 2000). Students were required to have a consent letter signed by their parents and themselves to demonstrate that they were familiar with the requirements of the research and that the transcripts would remain anonymous (see Appendix Four). This complied with the requirements of the Ethics Committee. The interviews took place on each school campus in the science classrooms, with freedom given to the students to elaborate on any questions that were asked in a relaxed setting. The interviews were of approximately 20 minutes duration. The interview data was then transcribed from the recordings. Students were asked the following common questions:

(1) Why did you choose to do a science subject in Year 12?
(2) How does your science teacher interest you in science?
(3) Do you plan on using science in your future career choices? If yes, why?
(4) What do you know about career pathways in science?
(5) Would you prefer a career pathway at university or TAFE? Why? Explain?

The staff interviews

Two science teachers from each of the five secondary schools were also interviewed after the student interviews were completed. Consent letters were signed by each teacher before the interview was carried out to comply with the Ethics Committee (see Appendix B for the consent forms signed by the teachers). These interviews were approximately 15 minutes duration. When interviewing the science teachers from each secondary school, the researcher investigated the teachers' views about the positive and negative experiences students have in science, and why they feel that students should study science as part of their education. It was also important to investigate if teachers had the information about pathways in science to pass on to their students and if they see this as part of their responsibility as science teachers. Teachers were also asked about their perception of the difference in the attitude of students towards TAFE and university pathways for post-Year 12 education. This qualitative data was transcribed to find the perceptions of science educators. The interviews asked the following common questions:

(1) Do you have opportunities to talk to students about careers in science?
(2) Do you see this as part of your job?
(3) What appears to be the factors that have the most influence over students' career choices?
(4) Do you feel that students perceive TAFE and university differently as options for tertiary education?

The Careers Counselor and Year 12 Coordinator (if applicable) from each secondary school were also interviewed about how students are informed of career options in science, and whether students are actively coming and seeing them in their exploration of post-secondary options. These interviews were of approximately 15 minutes duration. Consent letters were signed by each teacher before the interview was carried out to comply with ethics requirements (see Appendix C for a copy of the consent form used). The common questions were:

(1) How are students informed about career options in science?

(2) Do students specifically come and see you about careers in science?

(3) What programs are in place for Year 12 students to become informed about career choices?

(4) What appears to be the factors that have the most influence over students' career choices?

(5) Do you see any preference in students between university and TAFE options for their tertiary education?

Limitations of the Data Collection

A disadvantage of only focusing on surveying as a primary method of data collection is that there can be a limitation on free expression of opinions as a result of instrument-design considerations (Burns, 2000). However, by interviewing focus groups of students from each school, the researcher had the opportunity to observe the students and the situation in which they were responding. The advantage of this was that questions could be repeated if not understood, and the interviewer can press for additional information.

A limitations associated with interviews were that only 30 Year 12 students were interviewed over the five secondary schools. Scheduling time was also a problem, as it required the researcher to work in with the time slots available for secondary students and staff that were being interviewed. The researcher endeavoured to increase internal reliability by presenting the interview questions in the same manner. It is also relevant to note that the interviewer felt that there was a good rapport established with the respondents. Burns (2000) notes:

> Factors which may bias an interview include the personal characteristics of the interviewer; the opinions and expectations of the interviewer; and a desire to be perceived as socially acceptable by the respondent. Variations in the use of interview techniques, including tone of voice and the inconsistent use of

probes, also reduce standardisation. Validity and reliability are seriously affected by all of these factors (p. 583).

The researcher aimed to be sensitive to the different group interviews producing different perspectives on the same issues. This may be because interactions within groups has the ability to affect us all in terms of our actions and opinions (May, 2001). The researcher has taken care not to attribute the opinions of the focus groups to whole populations.

As mentioned previously, another limitation of the data is that the majority of students were from a higher socioeconomic background, and could be classified as high achieving students. Therefore, the findings are not representative of the wider population.

Data Analysis

The data collected was analysed primarily in a qualitative fashion, as there were many interviews conducted with students and staff which yielded very rich data which was able to be coded into emergent themes. The survey that was conducted had two open ended questions which produced qualitative data, and also a series of responses that were analysed quantitatively using SPSS.

The data collected in the first part of the survey was entered into SPSS and analysed quantitatively. Surveys that were incomplete were not included in the survey. Each school was coded from 1-V, and each student was allocated a record number from 1-401 to allow the data to be analysed. Each individual school was not analyed separately, as each students' data was pooled for analysis, as the findings were presented by coding of subject and participation, rather than individual schools. The aim was not to compare the schools, but to gain a large sample of Year 12 students' responses towards the survey.

Each item in the survey was individually analysed for all 401 students to rate their response in terms of what was true for them in their science subjects. The survey contained Likert style items where the students rated their responses as never, sometimes, often, very often or always. The items below are listed in the same order that they were presented in the survey.

In relation to each science subject, the items were as follows:

(1) My learning in this science subject will be relevant to my future
(2) My science teacher explains the relevance of topics we learn to everyday life
(3) This subject of science deals with topics that I am concerned with
(4) My science lessons in this subject have encouraged me to be interested in careers in science after Year 12
(5) My science teacher has encouraged my interest in a career in science
(6) I enjoy being able to understand and explain the concepts of science in this subject
(7) I find that science requires me to have to memorise a lot of information in this subject
(8) I find the practical work in science interesting and relevant in this subject
(9) I am curious about this area of science
(10)I am often bored with this science subject
(11)I find my teacher to be interested in this science subject

The factors that are most predominant in students' decision making for post-secondary options were also analysed with descriptive statistics to find out which factors had the most influence over their decisions for post-secondary options. Students were asked how these influences had affected their career choices. The students were asked to rate them as not influential, slightly influential, moderately influential, very or extremely influential. If students were not able to make a decision, they had the option of choosing not applicable.

In relation to career choice influences, the items were:

- Parental expectations
- University as a preferred option
- TAFE as a preferred option
- Work experience
- Peers
- Career education
- Academic ability
- Personal interest
- Employment opportunities
- Prestige in society/ salary potential
- Experiences in science
- Media/ newspaper/ TV influence
- Teacher expectations
- Teacher role models
- Advice of careers counselors
- Universtity information from universities or expos
- TAFE information

The two open-ended questions on the survey were analysed in a qualitative fashion to yield emergent themes that could be identified. Both sets of responses were collated by student and school number, and subsequently coded. The responses collected from the survey were coded by the following emergent themes:

- Teacher influence on enjoyment of science and/or career choices
- Parental/ sibling influence on career choices made
- Media influence on career choices made
- Prerequisites for further study on subject selection in Year 12
- University/TAFE preference for further education and/or information given for influence on career choice
- Enjoyment of science in the science classroom
- Personal interest in science leading to enjoyment of science and/or career choice in science
- Academic ability in science

Similarly, the interviews with students and their responses were also coded into emergent themes to identify their attitudes towards science, and the influences that seemed to be most predominant in their choices for post Year 12 schooling options. The responses were useful when interpreting the open ended responses that were collected in the surveys. The interviews were coded using the same themes that are listed above to endeavour to keep the research data focused on the themes that did emerge during the analysis of the data collected in this research. There was every effort not to constrain the range of interview responses by the coding procedure.

The interviews with science teaching staff, and school personnel such as Year 12 Coordinators and Careers Counselors were also coded to identify the factors that educators seemed to feel were the most pertinent in their influence on decisions made by the students upon completion of Year 12. It was also important to identify the programs there were in place for informing Year 12 students from each school about career options. These interviews were coded into the following themes:

- Teacher influence on enjoyment of science and/ or career choice
- Parental/sibling influence on career choices made
- Media influence on career choices made
- Preference of University or TAFE for further education
- Academic ability in science and personal interest in academic areas leading to career choices
- Information given to students about future possible career pathways

Using these emergent themes, it became possible for the researcher to further illustrate findings made in this research with qualitative data to support the findings made. The research findings will be presented in the following chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

The purpose of this chapter is to present an analysis of results collected from the survey and the focus group interviews with the students and staff from the five secondary schools that participated in the survey.

Students that participated in the survey studied one or two of the Year 12 Tertiary Entrance Examination (TEE) subjects of Physics, Chemistry, Human Biology and Biology or the wholly school assessed subject (non-TEE) of Senior Science. Results collected from all schools were combined, as the researcher was looking at the general perceptions held by the Year 12 science students that participated in the research, and not looking at comparisons between the different secondary schools. Table 1 below illustrates the numbers of students that participated in each subject, taking into account that 220 of the Year 12 students participated in more than one science subject in Year 12, and therefore responded in the survey for two subjects.

In the sample, it is recognised that there are a very small number of students that participated in Senior Science, in comparison to the number of students that participate in Chemistry, Physics and Human Biology and Biology. However, the perceptions from this small group of students were still considered to be important and valuable to the research conducted. The number of males and females is also included in the table below, although this research is not specifically addressing gender differences. It is recognised, however, that this would be a useful extension of this research and may yield some data that would be useful to science educators.

Table 1: *Number of survey respondents that studied each science subject (n=401)*

Year 12 science subject	Students that studied each subject *Subjects One and Two*	Males that studied each subject *Subjects One and Two*	Females that studied each subject *Subjects One and Two*
Chemistry	237	93	144
Physics	172	88	84
Human Biology	132	29	161
Biology	65	22	43
Senior Science	15	9	6

The survey was used to measure the perceptions held by Year 12 students in relation to their experiences of science in the classroom, their career aspirations and the factors that may have influenced their decisions for post-secondary education.

This chapter will address each of the three research questions that form the basis for the research that has been conducted.

The three research questions are as follows:

(1) What experiences are Year 12 students having in their science subjects?

(2) What aspects of science education are likely to influence the career aspirations of Year 12 science students?

(3) What other significant factors influence the career aspirations of Year 12 science students?

Research Question One:

What Experiences are Year 12 students Having in their Science Subjects?

Five secondary schools participated in the research with a total of 401 Year 12 science students responding to the attitude survey to rate their experiences in their one or two science subjects. The first part of the survey asked the students about their attitude towards a variety of aspects of science education. The responses of students have been separated into subject areas and each survey item was individually tabled.

The relevance of topics in science to everyday life

Year 12 science students were asked to rate their science teachers on the extent to which the teachers explained the relevance of topics to everyday life in their science classroom. These results are presented in Table 2.

Table 2: Year 12 science students' responses towards the item "My science teacher explains the relevance of topics we learn to everyday life".

Year 12 science subject	Percent and number of students that stated it was true very often or always
Human Biology	57 (75)
Biology	55 (36)
Physics	55 (94)
Senior Science	47 (7)
Chemistry	41 (96)

The results found that 57% of Human Biology students recorded that their science teacher related science to everyday life very often or always, followed by 55% of Biology students and 55% of Physics students. Fourty-seven percent of Senior Science students felt that their science teacher explained the relevance of learning situations, and only 41% of Chemistry students felt this to be true very often or always.

Some selected written survey comments received by students in relation to the importance of relevance of their science subject were as follows:

> I find chemistry irrelevant (at least in terms of the careers I wish to pursue), rather boring and quite difficult. Consequently, I have been put off furthering my studies of Chem at university! I much prefer the humanities, where I get a greater sense of satisfaction from what I'm learning.
>
> *School III, Chemistry (224) Career choice: Law*

> By learning about the human body, we can apply it to ourselves and get a better understanding of how it works and what we can do to improve our health and the health of others. The human body is indeed amazing and it's quite interesting to learn about our species.
>
> *School V, Physics, Chemistry and Human Biology (379) Career choice: Medicine*

The results could be explained by the course structure of the biological courses being very relevant to everyday life, as they relate to many experiences that students are having in their everyday life, such as the working of the human body, recycling, the role of plants and animals in life and so forth. The Physics course has been developed in previous years to have many applications also to everyday life, yet the Chemistry course has continued to be delivered in an abstract fashion with many formula and theories, with little relevance to everyday applications. The course delivered in Senior Science does vary from school to school, but generally there are attempts made to deliver a course that has relevance to the students participating in it.

The relevance of learning in science to the future of Year 12 science students

The idea of relevance was extended by asking Year 12 science students if they felt that their learning in science would be relevant to their future. These results are presented in Table 3.

Table 3: Year 12 science students' responses towards the item "My learning in science will be relevant to my future".

Year 12 science subject	**Percent and number of students that stated this to be true very often or always**
Human Biology	52 (69)
Physics	48 (82)
Chemistry	43 (101)
Biology	35 (23)
Senior Science	20 (3)

Human Biology students ranked the highest with 52% with 48% of Physics students and 43% of Chemistry students feeling that their learning in science would be relevant to their future very often or always. This was followed by only 35% of Biology students seeing relevance, and only 20% of Senior Science students felt that their learning in science would be relevant to their future.

Written survey comments collected from students from the attitude surveys indicated that when students saw relevance to everyday life, they found their studies in science much more rewarding.

> Like with Chemistry, want to apply my skills, but I find some of the physics units irrelevant in everyday life, there are many other exciting things we could study that actually will affect the future of the planet. ie. the environment.
>
> *School III, Physics and Chemistry (141) Career choice: Medicine*

> Studying biology has increased my awareness of the current environmental conditions which has inspired me to think about how I can use a career e.g. Journalism, to support the conservation movement.
>
> *School IV, Biology (47) Career choice: Law*

> Learning coursework helps me to understand the world around me, but applying my knowledge in projects sparked an interest in the science field (Physics).
> I really enjoy the balance in this course, and the content looking toward a career in medicine or medical science, chemistry is interesting and relevant to me.
>
> *School V, Physics and Chemistry (259) Career choice: Medicine*

It was interesting to note that while 55% of students that studied Biology perceived that their teachers explained the relevance of Biology to everyday life in the previous item, only 35% of these students actually thought Biology would be relevant to their own personal future. Reasonably high percentages of students felt that Human Biology, Physics and Chemistry would be relevant to their future, and this may be due to the course structure dealing with topics that have relevance to society, technology, industry and future employment. Senior Science was generally not perceived to be relevant to students' futures, and this may be due to a lack of interest in science on behalf of the learners, as it can often be students less motivated towards school studies that may opt for Senior Science in their post-compulsory secondary education.

Requirement of memorisation of science information

The requirement of having to memorise science information was also investigated with Year 12 science students. All science students surveyed were asked to rate their perception that learning science requires memorising a lot of information. The responses of the students are presented in Table 4.

Table 4: Year 12 science students' responses towards the item "I find that science requires me to have to memorise a lot of information".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Human Biology	92 (121)
Chemistry	58 (138)
Biology	57 (37)
Physics	37 (63)
Senior Science	0 (0)

It was found that 92% of Human Biology students felt that science required them to memorise a lot of information very often or always. One student commented in the written survey:

> It has not, as my interests and aspirations were set by the time of Yr 12 commencement. However, I feel Human Biology suffers due to its focus on raw memorisation (which also leads to heavy scaling) making the subject less popular and academically worthwhile.
>
> *School V, Human Biology (377) Career choice: Law*

Biology and Chemistry were also seen as subjects that required a fair amount of memorisation as 57% and 58% of students respectively felt that this happened very often or always. Only 37% of Physics students felt that science required memorisation and none of the Senior Science students recorded that they felt they had to memorise science taught in class.

The study of Human Biology is largely driven by content, and assessments often involve direct recall of information, hence it is often seen as a subject that requires a lot of memorisation. Biology and Chemistry have still quite a reasonable amount of factual recall, whilst Physics has been designed to be a subject that deals with applying

information learnt to different situations, leading to students having to understand concepts in order to do this. Senior Science is a subject that is often taught in a very practical way with assessments mainly focused on students' understandings of concepts taught or experienced, with less emphasis on factual recall. It is also important to note that the TEE subjects of Human Biology, Biology, Chemistry and Physics all have an external TEE exam at the completion of Year 12, whereas Senior Science is outcomes based, and there is no external exam at the completion of Year 12.

Enjoyment of understanding and explaining the concepts of science

The enjoyment of understanding and explaining the concepts of science in individual subjects was also asked of Year 12 students. Table 5 below summarises the responses from the Year 12 science students.

Table 5: Year 12 science students' responses towards the item "I enjoy being able to understand and explain the concepts of science".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Human Biology	58 (77)
Biology	57 (37)
Physics	56 (96)
Chemistry	52 (124)
Senior Science	33 (5)

Fifty-eight percent of Human Biology students stated that they enjoyed being able to understand and explain the concepts of this subject very often or always. Many students commented in the survey on their enjoyment of Human Biology. Human Biology is a very popular subject with the majority of Year 12 students, largely due to

the syllabus which teaches concepts in a very concrete way. The course is very applicable to everyday life, and students feel that they can relate their knowledge learnt to their own experiences. Some examples of the written survey comments are below:

> I was seriously considering becoming a nurse. This was because of my success in human biology as well as how much I enjoyed it. I found it was the one subject that if I put in the effort, I should get the results.
>
> *School III, Human Biology (239) Career choice: Nursing*

> I have always enjoyed science. Human Biology just strengthened that. I have looked at careers in science in particular subjects that relate to the many topics in Human Biology.
>
> *School III, Human Biology (381) Career choice: Defence Forces*

> I am very interested in the human body, and science associated with it. This subject has become highly interesting for me, and easy to learn because I enjoy it and it makes simple, logical sense. The evolution I study of early man wasn't very interesting, but the rest has been highly enjoyable.
>
> *School V, Chemistry and Human Biology (270) Career choice: Science*

The other subjects had similar results with 57% of Biology students expressing that they very often or always enjoyed learning about Biology. Fifty seven percent of Physics students and 52% of Chemistry students recorded that they enjoyed being able to understand and explain the concepts of Physics and Chemistry respectively. Written survey comments recorded from Physics and Chemistry students are illustrated below:

> I would like to continue studying physics by studying engineering next year. I really enjoyed the section on sound and would like to study a field of engineering concerned with acoustics and concert halls.
>
> *School III, Physics and Chemistry (146) Career choice: Medicine*

> I enjoy chemistry so it has encouraged a possible career path in Biochemistry.
> Studying physics has helped me acquire knowledge that is interesting and fascinating which may have an influence of my career aspirations.
>
> *School III, Physics and Chemistry (211) Career choice: Medicine*

I chose this subject because it sounded very appealing and very interesting and has made me consider more options in Physics.
I like Chemistry, particularly the practical and calculation aspects which has made me consider Pharmacy as a future option.

School IV, Physics and Chemistry (63) Career choice: Pharmacy

Fewer Senior Science students (33%) noted that they enjoyed being able to understand and explain Senior Science. As stated earlier, it is often those students who are less inclined towards science that opt for Senior Science, and as such, may not have such an avid interest in science in comparison to TEE science students. It is also important to realise that many TAFE bound Year 12 students will study Year 12 Senior Science to satisfy the prerequisite requirements for many non-science TAFE courses.

Curiosity about science

Year 12 science students were asked about their curiosity towards their science subjects. Table 6 below summarises the findings.

Table 6: Year 12 science students' responses towards the item "I am curious about this area of science".

Year 12 science subject	Percent of students that stated this to be true very often or always
Human Biology	59 (78)
Biology	55 (36)
Physics	51 (87)
Chemistry	39 (93)
Senior Science	27 (4)

Year 12 Human Biology students recorded the greatest level of curiosity about Human Biology with 59% of students reporting that they very often or always were curious about this subject. Fifty-five percent of Biology students were curious about their

subject. The biological sciences are often seen as relevant, interesting and applicable to everyday life by Year 12 science students. Selected written survey comments support these findings.

> By educating me about the natural environment, I am able to hypothesise about why things occur and am often very observant and curious. I am interested in the biological field, but the downfalls include the lack of interesting, motivating jobs – lab staff are often grumpy.
>
> *School V, Biology (366) Career choice: No career path specified*

> Biology's fun, lots of discoveries, not monotonous.
>
> *School V, Biology and Chemistry (367) Career choice: Science/commerce*

> I am very interested in genetics and the environment and because of this I am considering a career path in either genetics or some biology.
>
> *School V, Biology (372) Career choice: No career path specified*

Fifty-one percent of Physics students reported that they were curious very often or always about Physics. As discussed previously, the Year 12 Physics course has been designed as a very practical and relevant science course, and is largely applicable to everyday life, and as such seems to inspire curiosity in many Year 12 students. Chemistry students seemed to be less curious about Chemistry with only 39% of students recording that they were curious very often or always. The Year 12 Chemistry course is still largely focused on factual recall of information, memorisation of formulas and little emphasis on applications to everyday life. Thus, the course seems to not invoke curiosity in the majority of Year 12 science students. Only 27% of Senior Science students were curious about their subject very often or always. Again, this can possibly be attributed to the fact that these students may not have been curious about science before they began the course, even though Senior Science is a course that is usually designed around student interest, providing many meaningful experiences for students to enjoy within the context of science.

The relevance and interest of practical work in science

Practical work is very often carried out in Year 12 science subjects, and students were asked to rate whether they found the practical work that they carried out interesting and relevant. The student responses are illustrated in Table 7.

Table 7: Year 12 science students' responses towards the item "I find the practical work in science interesting and relevant".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Human Biology	55 (72)
Physics	54 (92)
Biology	52 (34)
Chemistry	46 (108)
Senior Science	13 (2)

Practical work was seen to be interesting and relevant for 55% of Human Biology students very often or always. Fifty-four percent of Physics students and 52% of Biology students also reported that they found practical work to be mostly interesting and relevant. Within these subjects of Human Biology, Physics and Biology, there are interesting practical applications that students obviously find within context and can see their relevance. A slightly lower percentage of 46% Chemistry students found practical work interesting and relevant, which may be because some of the practical work in Chemistry is designed to illustrate the use of formulae that are used in Chemistry, and it is often difficult to replicate much of the chemistry that occurs in industry that is discussed during this course. Only 13% of Senior Science students found any interest or relevance in practical work, which again reinforces that there is a possibility that some of these students are disenchanted with this subject. One student comment in regards to practical work is presented below.

> Don't like mathematics or practical work so though love the subject have opted not to go into a career which requires a lot of practical work and maths concepts.
>
> *School III, Human Biology (193) Career choice: Arts*

The subject of science dealing with topics of concern

Year 12 science students were also asked whether their science subject dealt with topics that they were personally concerned with. Table 8 illustrates the responses of the students that were surveyed.

Table 8: Year 12 science students' responses towards the item "The subject of science deals with topics that I am concerned with".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Human Biology	47 (62)
Biology	42 (27)
Physics	35 (60)
Chemistry	29 (68)
Senior Science	20 (3)

Forty-seven percent of Human Biology students felt that the subject dealt with topics of concern very often or always. Forty-two percent of Biology students felt that Biology dealt with topics of concern. Although these percentages are not high, it seems to be that students that study the biological sciences see the content covered as more relevant and more practical to everyday life. It may also be due to the fact that the biological sciences deal with a variety of ecological issues, human ecology and the impact of technology on society more so than the physical sciences. A lower percentage of Physics students (35%) felt that this occurred in class, and only 29% of Chemistry students felt that the subject dealt with topics of concern.

One Physics and Chemistry student comments in the written survey that he has found that by studying Physics in Year 12, he has found that he is interested in how some of the laws of physics affects the functioning of the human body. The comment is illustrated below:

> The interest in solving problems and learning about the laws of physics that apply to us and how they explain certain aspects of life influenced me to look into how they affect the human body.
>
> *School II, Physics and Chemistry (117) Career choice: Medicine*

Only 20% of Senior Science students felt that Senior Science dealt with topics of concern in class. This could be attributed to the lack of interest of individual students for reasons discussed previously, or that students do not see this subject as very relevant to their everyday life.

The interest of the teacher in science

Year 12 science students were asked some questions in the attitude survey in relation to their experiences of their science teacher, and how they were taught science in their respective secondary schools. Students were asked to comment on the interest that their teachers had in science, and the following results were collected and are summarised in Table 9.

Table 9: Year 12 science students' responses towards the item "I find my teacher to be interested in this science subject".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Biology	80 (52)
Chemistry	77 (112)
Human Biology	72 (95)
Physics	70 (120)
Senior Science	53 (8)

The results indicated that the majority of students found that their teachers were interested in their subject area with 80% of students feeling that their Biology teachers were very often or always interested. Chemistry and Human Biology teachers were also seen to be very interested in their subject with results of 77% and 72% respectively. Physics rated slightly lower at 70% with Senior Science teachers being seen as less interested with 53%. Written survey comments that were related to this item support the findings.

> The teachers at my school have been very influential as they obviously love their subjects and I have a really good friendship with almost all of them as they all care so much for us, and help us in any way they can.
>
> *School III, Physics and Chemistry (157) Careeer choice: Engineering*

> I love physics and over the time I've been studying physics, I have explored the idea of doing physics at Curtin uni. My interest has been along by my teachers who have always been supporting and so interested in me and the subjects they teach.
>
> *School IV, Physics and Chemistry (60) Career choice: Medicine*

> Although my science experiences have not influenced my career aspirations as such, I am fortunate enough to have an excellent enthusiastic teacher. I find it fascinating to learn about how my own body works, and think this information will be valuable to me in the future, however not as part of my career.
>
> *School V, Human Biology (374) Career choice: Design*

Some students expressed in their surveys the importance of teachers that are interested in their relevant disciplines, and how they are often disappointed if their teachers do not seem to be enjoying what they teach.

> As a lot of learning comes from the teacher, I find it HARD to learn physics. Even though my physics teacher is very dedicated, he can't teach. Therefore, I find it hard to be interested in physics and almost always bored in class.
>
> *School III, Physics and Chemistry (169) Career choice: Law*

> We had a substitute teacher for all of second term which showed me how hellish Chemistry can be if your teacher has different expectations of you.
>
> *School III, Physics and Chemistry (207) Career choice: Science/Arts*

> I enjoy studying physics. I do like physics but currently I find physics so boring because my teacher just can't explain the course really well. But I think if I do further study (physics) in uni, I'll find it more interesting.
>
> *School III, Physics and Chemistry (172) Career choice: Engineering*

Thus, it was apparent from the data collected, that the students expressed a range of views. It was noted that more students felt that their teachers were interested in their science discipline than those students that felt that the teachers were not interested. Whilst the majority of the TEE subjects were seen to be taught by teachers interested in their science subject by Year 12 science students, it was apparent that Senior Science students perceived their teachers to be less interested. This may be due to the fact that some teachers that teach Senior Science believe that this subject is of lesser importance than TEE subjects.

Research Question Two:

What Aspects of Science Education are Likely to Influence the Career Aspirations of Year 12 Science Students?

In the first part of the written survey administered to 401 Year 12 science students there were three items included that questioned the students about their thoughts of careers in science and how it had related to their science classroom. Focus group interviews conducted with six students from each school also added to this data by allowing these students to express some of their views of science and the impact that they may have had on career aspirations after completing Year 12. Science teachers that taught Year 12 students were also interviewed, and their thoughts on how science education may impact upon career aspirations have also been documented in the study.

Pursuing science after Year 12

One item asked the Year 12 science students whether they had been encouraged to pursue science after Year 12 due to their science experiences in their subject. The results were collected are presented in Table 10.

Table 10: Year 12 science students' responses towards the item "My science lessons in this subject have encouraged me to be interested in science after Year 12".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Biology	40 (26)
Human Biology	40 (52)
Physics	39 (65)
Chemistry	34 (81)
Senior Science	27 (4)

Forty percent of Biology students felt that their science lessons had encouraged them to be interested in science after Year 12 very often or always. Thirty-nine percent of Human Biology students felt this also, compared to 38% of Physics students and 34% of Chemistry students. Twenty-seven percent of Senior Science students felt that their science lessons had encouraged their further interest very often or always. These results were reasonably low for all subjects which is a concern in science education. The data indicates that nearly 60% of students were going to pursue a career in science (see Table 14), but many of these students felt that their interest in science had not been encouraged in their science lessons. However, there were some written comments collected from students that do illustrate that students are encouraged to pursue science if they are interested in their science lessons. These comments are illustrated:

> My studying of Human Biology has inspired me to continue my goal towards studying medicine in the future. Even though human biology is not a prerequisite or desired subject for medicine like Chemistry – it is a similar area of study to medicine and my interest in this subject has heightened my interest in medicine.
>
> *School III, Chemistry and Human Biology (145) Career choice: Medicine*

> They have encouraged me to be more involved in the application of science rather than the development of theoretical ideas (ie. I prefer engineering to science degrees in terms of what the work involves (physics). They have encouraged me to take an interest in work which involves sustainable energy production (renewable energy sources such as solar power and fuel cells).
>
> *School IV, Physics and Chemistry (50) Career choice: No career path noted*

> I really enjoy the balance in this course, and the content looking toward a career in medicine or medical science, chemistry is interesting and relevant to me.
>
> *School V, Physics and Chemistry (259) Career choice: Medicine*

It is possible that many Year 12 science students that study a TEE science subject are already interested in science and may already be planning a career in science, and many students are taking part in science as they are subjects that can contribute to a TEE rank that is useful for entry to many tertiary courses at university. In reference to

Senior Science, it would be expected that many of these students are possibly not planning on a career in science, and that their science lessons have little influence on their future career plans.

Science teachers encouraging an interest in a career in science

Year 12 science students were also asked whether their science teachers had encouraged their interest in a career in science. Table 11 presents these findings.

Table 11: Year 12 science students' responses towards the item "My science teacher has encouraged my interest in a career in science".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Biology	26 (17)
Chemistry	26 (62)
Physics	24 (41)
Human Biology	14 (19)
Senior Science	7 (1)

When surveyed, only 26% of students in both Biology and Chemistry felt that their teacher had very often or always encouraged their interest in a career in science. Twenty-four percent of Physics students acknowledged their teachers as being encouraging towards a career in science. Only 14% of Human Biology students felt that their teachers encouraged their interest which is surprising, considering the high ratings that the subject of Human Biology had previously gained from students. Only 7% of Senior Science students recognised their teachers as being very often or always encouraging. As one student comments in the written survey:

> Have thought about being an industrial chemist, but was told by my teacher that you get called out at 3am!
>
> *School III, Physics and Chemistry (169) Career choice: Law*

Considering the very high ratings of students that felt that their teachers were interested in their science subjects (ranging from 53% for Senior Science to 80% for Biology), it is surprising that the majority of the students felt that their teachers had not really encouraged their interest in a career in science. This may be due to the lack of time during the year to discuss career options that relate to the particular subject, or that teachers do not feel that it is part of their job description to deal with this particular topic. It could also be due to science teacher's lack of expertise in career pathways. It was evidenced during the focus group interviews that students did appreciate science teachers' guidance in possible career pathways. During the focus group interviews, two students from School IV commented about the role of their science teachers in encouraging them towards career goals.

> I think the science teachers actually do play a big part in this. Maybe not for you with the career in medicine so much, where my teacher isn't actually able to guide you into that kind of career path as much, but because I'm interested in more of a science, like full science based career, he's actually told me a lot about what aspects in each career and what kind of chemistry or physics is required in it. *(Student: School IV)*

> I find actually that it's more the grades with the teacher, they help with that sort of thing. They tell me "this is the sort of grade you're getting and this is the sort of thing that you're looking for", so these are your boundaries, so to say that's good in a way I suppose, but it's also restricting in a way. So, I think what I've done is I've blocked all that, I mean, it's not exactly the best thing to admit to, but the thing is they talk about careers or they talk about your grades or they talk about whatever it is that they think might be good for you and I understand that, but I think I've blocked it out and I've thought I'll see what I can do first and then I'll listen to somebody else. *(Student: School IV)*

During the focus group interviews with science teachers, some of the following comments were recorded and transcribed from teachers that were involved in teaching Year 12 science students.

> ... sometimes there are opportunities in class when you're going through particular topics you can – like in organic chemistry, for example, you can talk about the opportunities in

material science and so forth, but probably there's not much or not enough kind of discussion about what opportunities there are. *(Science teacher: School II)*

I think it happens when you're doing things, so as you're teaching and you talk about "well, this topic leads to people who are doing this" or you use experiments. You talk about people who you know or you've read about or you talk about scientists who get involved in this field and do work in that. *(Science teacher: School III)*

...there are often instances from the beginning of year, particularly the beginning of Year 12 onwards, where kids are sort of starting to explore different possibilities in the physical sciences...the kids who are in the middle of the road, who are interested in either sciences, then start to interrogate me about, you know, what are the opportunities – you know, what does a physicist do or, you know, what does a microbiologist or a chiropractor or a physiotherapist or whatever...I don't know a lot about all of these careers but I can certainly direct them to sources, like the guidance counselor, the careers counselors or any people who are working in the field. Quite often I'll give kids numbers of people that they can talk to. *(Science teacher: School IV)*

It was interesting to note that while some of the teachers saw themselves as playing an active role in guiding the students towards particular areas for their future careers, other teachers did not see that it was particularly their role or area of expertise.

Exploring career paths in science

The Year 12 science students were also asked if they had explored career paths in the particular subject that they were studying. Table 12 presents the findings from this particular item.

Table 12: Year 12 science students' responses towards the item "I have explored career paths in science".

Year 12 science subject	Percent and number of students that stated this to be true very often or always
Human Biology	46 (61)
Biology	43 (32)
Physics	37 (65)
Chemistry	33 (54)
Senior Science	20 (3)

Forty six percent of Human Biology students felt that they had actively explored career paths in science, closely followed by 43% of Biology students. Some of the written survey comments from such students are presented below.

> My knowledge in the human body and how it works has sparked my interest so now I am thinking about becoming a nurse.
>
> *School V, Human Biology (335) Career choice: Nursing*

> I am very interested in genetics and the environment and because of this I am considering a career path in either genetics or some biology.
>
> *School V, Biology (372) Career choice: No career path specified*

> Thinking about something to do with genetics – although still unsure as to how much the other sciences will be involved.
>
> *School V, Human Biology (386) Career choice: Genetics*

Thirty-seven percent of Physics students had explored career paths in Physics with 33% of Chemistry students opting to explore careers in Chemistry. Some written survey comments from Physics and Chemistry students illustrate their feelings about exploration of career paths.

My enjoyment of all my science subjects over Yr 11 and 12 has been the defining factor of my choice of medicine as being my tertiary study path.
I love physics and over the time I've been studying physics, I have explored the idea of doing physics at Curtin uni. My interest has been along by my teachers who have always been supporting and so interested in me and the subjects they teach.

School IV, Physics and Chemistry (60) Career choice: Medicine

TEE Chemistry has influenced me to be interested in a career using Chemistry, such as Pharmacology for example. Many university courses require TEE Chemistry as a prerequisite, and by doing this subject, I have been granted the opportunity to select a career in science.

School V, Physics and Chemistry (307) Career choice: Psychology or Pharmacology

An enjoyment in science areas has encouraged me to look at it for a future career. My interest in these subjects will be carried on to a career (Physics).
My science experiences have caused me to take an interest in a career in science (Chemistry).

School V, Physics and Chemistry (393) Career choice: Medical Imaging Technology

It can be seen from the data collected that there is the perception that more students that study the biological sciences are exploring career paths in science than those student that study the physical sciences. This could be attributed to the larger range of career choices that lead from the biological sciences such as environmental sciences, health sciences and other such related careers. Many of the careers in the physical sciences, such as medical careers, engineering and others could be viewed as more academically competitive, requiring higher academic success. This may explain the marginally lower numbers of Physics and Chemistry students that have explored careers in science, as their exploration would depend upon how academically successful they were in their studies in their respective subjects. Only 20% of Senior Science students had opted to explore career paths in areas of science studied. The low number of Senior Science students that are exploring career pathways in science could be attributed to the less scientifically able students that opt to study this subject, and the lack of confidence that they may have in their science ability.

Research Question Three:

What are the Other Significant Factors that are Influencing the Career Aspirations of Year 12 Science Students?

In the survey, 401 Year 12 science students were provided with a list of factors and asked to rate the degree to which the factors were influential in affecting their personal career choices. The factors that were listed ranged from students' personal interest and academic ability to school based factors and also a range of external factors based on students' response. The factors are ranked in order from most influential to least influential in Table 13.

Table 13: Factors influential in affecting career choices of Year 12 science students

Factors affecting career choices of Year 12 science students	**Percent of students that rated the factors as very or extremely influential to their career choice (n=401)**
Personal interest	88
University as a preferred option	74
Academic ability	68
Employment opportunities	59
Prestige in society/ salary potential	43
University information from universities/expos	38
Parental expectations	38
My experiences in science	31
Career education	18
Work experience	18
Peers	17
Media/ TV/ newspaper influence	14
Teacher expectations	13
Teacher role models	10
Career advice from careers counselors	9
TAFE as a preferred option	7
TAFE information	7

Personal interest and academic ability of students

Personal interest was the most influential factor (88%) for the Year 12 science students with academic ability also being rated as highly influential with 74% of students rating it in this manner. Written comments from the attitude survey illustrate the importance of personal interest for many of the students.

> Personal experience in the profession and how it has affected my life made me decide to choose medicine as my first preference.
>
> *School II, Physics and Chemistry (117) Career choice: Medicine*

> I make my own choices. By myself. It's my future.
>
> *School IV, Human Biology (33) Career choice: Hospitality at TAFE*

> I think personal interest should have the most effect on what I choose to do. All the other influences have little impact but do inform me and make me more sure or more interested. In the end though, it's still my choice.
>
> *School IV, Physics (260) Career choice: Commerce*

> My own interests drive me aspirations for after Year 12, but my parents are influential because they place a lot of importance on my academic performance. I also want to go to a uni where my friends are. I admire friends of mine who are independent and doing what they want to do (ie. Uni other that UWA) to do a course not offered at UWA or going to TAFE to do something they are passionate about.
>
> *School III, Chemistry (144) Career choice: Medicine*

Academic ability in science is also seen as important as illustrated by one student's comment.

> I am only doing Chemistry as it is a prerequisite for the course I want to do at uni. I have been extremely bored with chem. In Year 12 and find the memorizing of equations etc to be excruciating. I do poorly in Chemistry and depend on notes in my calculator, so I don't look at chemistry as a career option.
>
> *School III, Chemistry and Biology (198) Career choice: Biology*

It seems clear that most students wish to pursue a career that will satisfy their personal interest, and that fits in line with their perceived academic ability. Year 12 students are exposed to so many choices for their career options, that it makes sense that they would recognise that they are able to pursue personal interests. It also seems to be evident that the majority of students are trying to make career choices that are going to be suited to their academic ability.

University and TAFE

When the students were asked to rate factors as being highly influential to not influential, university as a preferred option was rated by 74% of students as being very highly influential in contrast to only 7% of Year 12 students rating TAFE as a preferred option as being highly influential. This could possibly be due to the cohort of students that were surveyed, as the majority of the students surveyed were participating in a Year 12 TEE course, and already planning on being university bound after the completion of Year 12. It could be perceived from this data that Year 12 students see that university has more prestige, offers more varied courses and therefore creates greater employment opportunities with higher salary potential. One written comment from the survey illustrates this idea:

> Universities appear to be glorified and TAFE more marginalized therefore it has had an effect on me in the sense that I work to get the approximate TER score. I have never even considered TAFE because of the connotations that people go there if they couldn't make it at uni. Also university open days have been a major influence as it provides a hands-on, first glimpse at what you're getting into.
>
> *School III, Human Biology (236) Career choice: Journalism*

Similarly the university talks that were offered to Year 12 students during the year influenced only 37% of the students to a high degree, with TAFE talks only having a high influence on 7% of students. The following written survey comment demonstrates a student's feelings about the value of university talks.

> I've been to a physio seminar, there Physio's informed us on EVERYTHING (basically) about the job. ..(eg. Not just sports physio like everyone wants to do). ..Detailed information on course and what it is like as a physio. Actually told whether they are happy in job and talked about pros and cons of job.
>
> *School V, Human Biology and Chemistry (376) Career choice: Physiotherapy*

In the written survey, the students were asked what their areas of interest were if they were planning on a course for tertiary study. Table 14 illustrates the results collected from these students.

Table 14: Courses selected by Year 12 students in Schools I-V

Year 12 course selected	**Percentage of students in Year 12 from Schools I – V (n=401)**
University science course	58
University non-science course	30
TAFE science course	1
TAFE non-science course	3
Other (Defence forces/apprenticeships)	1
No course noted	7

The research indicated that 89% of students were considering a university course preference with 58% of students considering a specific science university course, which is a reasonably high number of students. Science courses were defined as tertiary courses involved in biological science (e.g. Psychology, environmental areas), medicine, physical science courses, nursing and other related courses such as mathematics or computing. Keeping in mind that all of the students surveyed were participating in a Year 12 science subject, this is perhaps not surprising as many of these students would have selected their science subjects in Year 11 as prerequisites for the tertiary courses.

The sample of students surveyed from Schools I-V were from a range of socioeconomic areas with a higher percentage from schools of middle to high socioeconomic areas. It seems that TAFE is an option which is not seriously considered by the majority of Year 12 science students with only 4% opting for TAFE pathways three months before the completion of Year 12. It must also be noted that many of the potential TAFE students come from students that were studying Senior Science and this sample contained only 15 students.

During the focus group interviews with Year 12 science students, their comments reinforced the view that most students saw TAFE as an unattractive option in comparison to attending university for their tertiary education. Some of the comments collected from such students are listed below.

> I don't really know much about TAFE. I suppose I have the stereotypical view in a way, that it's kind of the place you go if you don't do as well at studies or whatever, which probably isn't true at all because some of the courses that they offer are probably really good, but I've just never thought about it. I've always just wanted to – I just assumed that uni would be where I went after school. *(Student: School III)*

> There is a huge rift between going to university and TAFE and they expect a lot of you either way. It doesn't really matter. But going to university is – it's expects a lot. It bases a lot just on your marks. It can be based just on your TEE scores, whereas as TAFE is slightly different, so you could say TAFE is slightly easier.*(Student: School IV)*

> I suppose I see university as more prestigious, with better paid jobs. *(Student: School V)*

Science teachers and careers counselors also support the notion that students do prefer university options for careers rather than TAFE options. Some comments are below:

> There's a certain amount of pressure on the students themselves to get to university. Their parents haven't spent all this money on their education and the boys just feel it's easier to comply than to argue with and go along that path. The most influential thing that's happened in recent years is the very clear guidelines that are given for a pathway through TAFE into university, and that provides a sensible option *(Careers Counselor: School II)*

> Most of our kids want to go to university. That's a bit of a sore point because we get kids trying to do TEE courses when they're really not suited to the, you know, for whatever reason. Often the parents want them to have a go at TEE and so we get kids who are really not capable of doing TEE courses, but we promote TAFE just as we do tertiary institutions. *(Science teacher: School V)*

> We'd far sooner see them going into TAFE with A grades and B grades and guaranteeing places in their courses that the nothingness and then having closed doors and that sort of disappointment. *(Science teacher: School V)*

It is clear from the comments collected from science teachers and careers counselors that university is the preferred option of the majority of the students that they come into contact with. TAFE was seen by many of the students surveyed and interviewed to be a lesser option in comparison to university. This may be due to the students' perceptions that if they are enrolled in a TEE course during Year 12, the expectation is that they will go on to further studies at a university level as the TEE course is most noted as the obvious prerequisite for entry into university for school leavers.

Employment opportunities and salary potential

Fifty-nine percent of Year 12 students felt that employment opportunities were very to extremely influential in making their career choices, with only 14% of students deeming employment opportunities as not or slightly influential. Salary potential was moderately influential in affecting career choices of 43% of Year 12 science students. Students were asked in the survey to cite any other influential factors that influenced their career options by written comment form.

> I want a career that works with people and makes a reasonable amount of money. I love the arts subjects, hence and arts/commerce degree. The commerce part will place me in good stead if I want to venture into the corporate world.
>
> *School III, Chemistry, (174) Career choice: Commerce*

> People are influenced by attractive pay packages.
>
> *School IV, Physics and Chemistry, (48) Engineering*

It could be perceived that students feel it is more important to be employed at the end of any tertiary education and have opportunities available to them. Although salary potential is seen as moderately important to these Year 12 students, it is indicated that employment opportunities are seen as more influential in making career choices.

Parental and family influences

Parental expectations was not as influential as might be expected with only 37% of students seeing it as being very or extremely influential in career choices made. Comments collected from the survey data illustrated the importance of parental expectations for some students, as well as influence from family members and siblings.

> Many family friends have careers in medicine and this has influenced my choice. My father is a chemical engineer influencing my choice in engineering.
>
> *School III, Physics and Chemistry (143) Career choice: Medicine and Engineering*

> What my elder sisters are studying at university influences my choices, because of expectations it puts onto me as well as my own aspirations to do things I have heard them talk about.
>
> *School III, Physics and Chemistry (149) Career choice: Medicine*

During a focus group interview with a student from School III, the following comments from one student were recorded and transcribed.

Student:	My parents don't want me to do nursing. My brother – I'm a quadruplet – so my brother and two sisters are all going for dentistry or medicine and I want to do nursing, but that's fine. They don't think I should do nursing...
Interviewer:	Is there pressure?
Student:	Yeah, Mum drops hints every now and again that she doesn't think I would be, I should do nursing, and she pops in the exercise and health science thing... I'm not interested in that - but I kind of more want to do nursing because I want to come up being something. I'm a very practical person and to know that at the end of my

degree I will be a nurse or a physio – that's something I'm interested in – not just have a degree.

Interviewer: And what do your parents do?

Student: My Dad is an engineer, a mechanical engineer...My Mum has a degree in English literature, an arty kind of thing. She was a teacher, she taught English lit. and she now wishes she'd done something else. She's very, wishes she hadn't stopped working to look after us, but she kind of had to because there was a lot of us. She's looking at going back into work. She's done a course in horticulture and stuff. That's what she really wanted to do, but she didn't get that opportunity.

Interviewer: And with your siblings, is there pressure from them about what you're doing or they're ...

Student: : No, there isn't really any pressure, but my sister actually did work experience - she wants to be a doctor - but she did work experience with the nursing, just to be in the hospital, and she said that it was – she spent a lot of time bathing people and things like that...

This interview shows the pressure that this student feels from both her parents, and possibly her sister as well. Although many of the students surveyed did not rate parental influences as high, the students that do experience seem to find that perceived expectations will influence their career aspirations.

The focus group interviews with students generated many comments from the students about the role of parental influences. Although, many of the students interviewed did stress that it was their decision in the end, the influence of parents obviously does make a fairly influential impact. This is illustrated by one student below:

> My parents have had a huge impact on the way I think about my future. Not so much my friends because it's the same thing with teachers. They might think they're doing it for your own benefit and that sort of thing, but it's not because it's not the way you think, so I think it's more parents and more my own choice than anyone else. *(Student: School IV)*

Careers counselors and teachers also expressed their views about the roles of parents in the career decision making of Year 12 students. It seemed to be a common assumption by careers counselors and science teachers that parents seem to have a

fairly substantial influence on the career aspirations of their children in the secondary schools that participated in the research which was expressed in the interview data collected from these teachers. The comments that have been collected from a range of careers counselors and science teachers are representative of many of the comments made.

> ...Unfortunately some parents just completely ignore the advice of the school and even though the school is actually stating "we believe that if your student goes along this path they're likely to fail", you know, "you still have the right to do it" and they push them down that track and then they jump ship halfway through the year, you know, which is unfortunate because it's sort of like "we told you so", you know. I think it's a shame they don't take a bit more heed in what the teachers say. *(Careers Counselor: School I)*

> What appears to be the factors that have most influence over students' career choices? Their parents, first and foremost, particularly in this school because we are a migrant school and the migrant parents have a very big input into what their students should be doing. Sometimes the ideas are not in keeping with the kid's ability and we have to talk to the parents about alternative career choices or alternative study programs for the kids, because they all think their kids are going to university when sometimes that's not actually possible. *Careers Counselor: School IV)*

> I think with some of our multicultural students there certainly is some career expectations upon them and some, yeah, that are looking to become doctors and dentists perhaps aren't capable of it, but their parents are insisting that they do it and no matter what you tell them...So convincing the parents is probably one of the hardest aspects and I'd say they get most of their aspirations from their parents. *(Science Teacher: School V)*

It is therefore, very evident that teachers and careers counselors see parental influence as a very strong influence on the career aspirations of Year 12 students. It possibly could be a very subtle influence in many of the cases, so that students are not entirely aware of how much parents' expectations may actually influence their decisions.

Work experience offered in Year 10

Work experience offered in Year 10 was seen to be highly influential by only 18% of Year 12 students. However, for some students, work experience was deemed to be helpful in making career decisions for after Year 12. Two written comments from the survey are illustrated below:

> Yeah, I think there has, like work experience in Year 10 really helped, because otherwise if I didn't do that I would have been doing environmental science, and I wouldn't have realised that I didn't like it, but I think we're really too young to decide what we want to do, looking into careers and universities and things. It's too hard. *(Student: School III)*

> I have talked to other people who are doing Dental Assisting in TAFE and found out what they think about it. And I talked to my dentist and places where I did work experience. I found out the goods and bads and the pathway they took to get where they are.
>
> *School V, Human Biology (390) Career choice: Dental assistant*

Possibly by Year 12, it could be perceived that work experience in Year 10 has lessened in impact, as many students have made more of their own choices based on more relevant current experiences and information. Also, it is possible that the work experience completed in Year 10 was not in the area that the students' future career aspirations lie, and this of course, would make the whole experience in Year 10 much less influential. What also must be considered is that work experience may also aid students in ruling out options for career choice, as they may have felt the work experience did not cause them to favourable consider that career as a further option.

The influence of peers

Peers were seen to be much less influential in career decisions that Year 12 students make with only 17% of students ranking peers as very or extremely influential and 47% of students identifying peers as not influential or slightly influential. Two students during a focus group interview from Schools IV and School V comments about peers.

> Well, I get two really contradicting views from my peers and my family. My family wants me to do like the hardest subjects. They want me to do like medicine or law and I'm not particularly interested in that, and my peers want me to do what will make me happy and stuff like so, you know, parents want money, peers want you to be happy, so it's really hard to decide. But, you know, in the end it's actually up to you, what you want to do so I try and block out what other people say and make it more of my choice. I try and get advice from them, but in the end it does come down to what I want to be doing later on in life. *(Student: School IV)*

There were some interesting comments made from some students about the influence that peers had on the decision to attend university and TAFE. It was clear from many of the comments made by students that university was perceived to be seen as a much more preferable option in Year 12 peer groups. Some written survey comments are illustrated below.

> ...I feel that the pressure for getting into university has come definitely from peers in that aspect. Like to make it to university, because everyone's going to university and some of my friends – I was like "well, maybe TAFE as an option" and they just laughed because "why would anyone settle for TAFE when you can go to university?". (*Student: School V)*

> ...I've noticed like socially wise, that there's been break ups of groups, not specifically because of it, but you can notice that you go "oh, that poor person, why are they going to TAFE" or "oh, that poor girl, I thought she could do a lot better than that". *(Student: School V)*

So, although there appears to be an influence of peers in some aspects of career aspirations, overall students didn't rate it as influential as other factors. It is possible that by the time students have reached Year 12, they are more autonomous in their decision making and less influenced by what their peers think in terms of the particular career fields that they wish to pursue.

The influence of media and television

Media and TV also did not have any great influence with only 14% of students seeing this as very or extremely influential to their career choice. By the time students have reached Year 12, it would be expected that they are no longer being influenced by what they observe on television or see through a variety of media, as different occupations have possibly been less glamourised through their own individual research and information from teachers, parents and siblings.

The expectations of teachers and teacher role models

The expectations of the teacher and teacher role models were not seen as highly influential to Year 12 students with only 13% and 10% of students respectively deeming these factors as highly influential. When interviewed, students did not seem to perceive that teachers were very influential in their decisions made concerning career choices, and very few comments were made by students in this respect. However, when interviewed, several science teachers commented on how they made an effort to help to educate the students about careers in science. For example, it also must be noted that only science teachers were interviewed, and there may have been teachers in other disciplines that acted to influence the students that were surveyed in respect to their career choices. One science teacher made the comments below in the recorded interviews.

> And I think, you know, I mention to kids – especially in human biology and biology too – about things that come up in the newspaper, you know, research that's been reported and that sort of thing and I think kids pick up on that and they think "oh, you know, that's what a scientist does" – it comes out in things like that, so you tell them about health issues that have been in the newspaper. Sometimes I pass newspaper cuttings around and that sort of gives them an idea of what scientists do as well. *(Science teacher: School V)*

The role of careers counselors and career education

From the written survey that students participated in, it was found that the advice from the career counselors was not seen as very influential at all with only 9% of students rating their advice as very or extremely influential, and structured career education during school hours only rated slightly higher with 18% of students deeming it to be very or extremely influential. It seemed that many of the students perceived that there was quite a bit of information available during Year 10, but felt that in Year 12, there was less access to careers counselors and relevant career advice. During the focus group interviews, the researcher felt that many of these students perceived that it was up to the individual students to find out all the information, and at times they felt quite overwhelmed by this, and would have liked to have some more structured advice from the careers counselors.

During the focus group interviews with students, the following comments were recorded and transcribed as to the students' opinions of the role of careers counselors.

> You can't say that she's not good with the resources (the careers counselor) because she will go a long way for you, but there is only one of her and there is a lot of students that she has to run around after. *(Student: School IV)*

> When you do come up to this stage in Year 12 and you've got a lot of study to do where you've more or less made up your mind for some people the right choice, for some people the bad choice, you haven't got enough information on what you do if you make the wrong choice... you don't have enough information on that and you don't have enough information on what happens if you do get it wrong and how you fix yourself up from there. *(Student: School IV)*

During the focus group interviews with the careers counselors from the various schools involved in the study, the perception of the role of careers counselors was seen to be much more influential from the careers counselor's viewpoint. This is of interest due to the fact that students are rating the role of careers counselors as not very influential, yet the careers counselors are seeing themselves as quite influential. This contrast of roles is significant for educators as although they may be doing quite a lot

of work for the students, it could be perceived that the students are not always recognising that they have this resource to find information from regarding their career aspirations. A representative comment by one careers counselor at School I illustrated the perceptions held by many of the careers counselors as their role in career education for Year 12 students.

> Right, well in Year 12 itself, we have a program where we have a number of guest speakers that address the students....Yeah, that's the main way that we inform them about - directly from the universities. Then there's a lot of information that comes out through to me via email and flyers, those sort of things – advertisements about open days and that, so it's up to me to make sure that that is advertised on our careers notice board and also in our daily notices and we also, because they don't always get read out. *(Careers Counselor: School I)*

A common consensus amongst the careers counselors that were interviewed was that if the students were interested in science career by Year 12, they had completed a lot of their own research, and were less dependent on the career advice offered by the careers counselor. One comment from the focus group interviews illustrates this:

> Most of the students in fact have already got some sort of idea when it comes to science. Science kids, maths kids tend to be more motivated than the kids who have more of an interest in the social sciences side of it. They are generally heading towards the technology areas, the maths areas, the chemistry, the biochemistry, the industrial chemistry, the engineering or megatronics is another one that's coming up, and most of those kids have already established their interests so they don't have to see me specifically about what should they do within the science field. They certainly come and talk to me about what may be available within that area, but they've already got ideas anyway. *(Careers Counselor: School IV)*

It may be that by the time students have reached Year 12, they already have defined their preferred career paths and are less dependent upon advice of careers counselors. It was expressed, however, that many Year 12 students would like more guidance in making particular choices or receiving information from careers counselors whilst in Year 12.

Chapter Summary

These findings help to clarify the importance of science education in helping Year 12 students in forming their own personal career aspirations. The Year 12 students that participated in the research mostly seem to be experiencing positive experiences in science, and many are considering science based careers.

The aspects of science education that seem to be most likely to influence the career aspirations of Year 12 science students are the students personal interest in science with the respective teachers and science lessons having some impact as well.

Significant factors, other than science education, that significantly influence the career aspirations of Year 12 science students are personal interest, academic ability, the preference for university entrance, employment opportunities and salary potential. It is also recognised that parental expectations and experiences in science also play a part in many of these students' career aspirations.

The final chapter will summarise the key findings of the research, and endeavour to make recommendations to improve the outcomes of science education for Year 12 science students.

CHAPTER FIVE

CONCLUSIONS

Introduction

This chapter will summarise the key findings from this research that was conducted with the Year 12 science students. It should be noted that the sample is not necessarily representative of all Year 12 students, so therefore recommendations and suggestions drawn are only applicable to the sample of students that participated in this particular research.

The research questions under investigation were:

(1) What experiences are Year 12 students having in their science subjects?
(2) What aspects of science education are likely to influence the career aspirations of Year 12 science students?
(3) What other significant factors influence the career aspirations of Year 12 science students?

Although gender of students was discussed in the literature review, it has not been dealt with during this research as this research has not focused on the different career aspirations for different genders. This is largely due to the fact that many more females participated in the research, and there would be no clear assertions drawn from this data. However, this topic could be worth looking at in the future as it is a real issue in science education, and would be worthy of some further research.

Each research question will be dealt with separately during this chapter, and the general findings and implications of these findings will be discussed.

Research Question One:
What Experiences are Year 12 Students Having in Science?

General findings

Assertion One

Students find that having their science learning related to everyday life makes their science learning more relevant to their future.

Nearly half of the students in all areas of science felt their science teachers related their teaching areas in science to everyday life. Those subjects that rated their teachers as doing this slightly less in the classroom were Chemistry and Senior Science students. This is possibly due to the courses in the Biological Sciences and Physics relating to the experiences that students are actually having at this time in their lives. Human Biology, as a course, deals with many relevant aspects to students in terms of body functioning, so it is not surprising that students will see it as relevant. As mentioned previously, the Physics course has been developed to specifically relate to everyday applications and this is obviously influencing those students surveyed. The enjoyment of science by the students could also possibly be due to the future career aspirations of these students, as if their chosen professions are not related to a specific science, they may not see the relevance of their information learnt, or display personal interest in the content taught. It was evident by the comments collected from students from the survey and from the focus group interviews, that enjoyment of science was a major precursor to students choosing to explore careers in science.

When asked if subjects dealt with topics of concern, just under half of the students that participated in biological sciences felt this to be true. This is most likely due to these topics dealing with environmental issues, health, human ecology and the impact of technology on the environment to name a few. Approximately a third of Physics

students felt that this was true, with lower numbers in Chemistry reporting that they felt their subject dealt with topics of concern. The low level of students in physical science that recorded that the topics taught were of concern could be due to the more specific issues that are dealt with in this topic that are not that applicable to adolescents at this stage of their life. Many of the issues taught in these topics will become more of concern as the Year 12 students became older. Only one fifth of Senior Science students felt that their subjects dealt with topics of concern.

Assertion Two

Students enjoy being able to understand and explain the concepts of science.

Enjoyment of science is an important aspect of Year 12 science education, and for all TEE subjects, over half the students felt that they enjoyed being able to understand and explain the concepts of science. This is very heartening to science educators in the schools that participated in the research. A lower number of Senior Science students felt this to be true, and this may be due to the fact that many of these students did not begin their course with a very high interest in it. Many students who opt for TEE science have either a personal interest in science or require it as a prerequisite for tertiary bound courses. Students that studied Human Biology, Biology or Physics all expressed that they had a reasonably high degree of curiosity about science, yet decidedly less Chemistry students noted that they were curious about their course. Again, fairly low numbers of Senior Science students stated that they felt curious about their area of science. Although Human Biology does rely on quite a high factual recall of information, the subject does seem to deal with many facets of the human body which does inspire student curiosity. As Chemistry deals with a lot of industry based applications, this may not be seen as applicable to students of teenage years. Senior Science is a very hands on course, but the subjects attracts disinterested students, this would account for the low levels of curiosity expressed by such students.

Assertion Three

Students found that many of their science teachers were interested in their science subjects

Students' perceptions of how interested their teachers were in science came up as highly favourable, with the majority of Biology, Chemistry and Human Biology and Physics students feeling that their teachers were very interested in their science subjects. This is very encouraging, as the teacher's personal interest in their subject is noticeable to the students, and hence would encourage students' interest in their subject. Senior Science teachers were seen to be less interested in their subject, and this may be due to the fact that some teachers teach Senior Science in addition to their chosen discipline in science which is normally biological or physical sciences. Some teachers are not that personally interested in teaching the course in Senior Science, and more emphasis in many of the schools that participated in the research is on the TEE courses as the majority of the students in these schools are university bound.

Suggestions for improvement

- It is important that teachers teach their content in their subjects in an interesting and relevant way, taking care to evoke curiosity in their students. Students enjoy science if it is taught in a relevant fashion, and like to be able to explain and enjoy the subject. Each subject should have time to deal with topics of concern in today's society with real life issues playing a major part in the syllabus. Goodrum, Hackling and Rennie (2001) have expressed concern that the science being taught and the learning outcomes achieved are not those that will adequately prepare students for the future world in which they will be living. This has been further supported by Osborne and Collins (2001) who note that good rapport between teachers and students will allow opportunities to surface that will raise questions and discuss aspects of science, thus

highlighting the relevance of science to everyday life and to the students' futures. Classroom science needs to be placed in a real world context to make it relevant to everyday life (Committee for the Review of Teaching and Teacher Education, 2003).

- Teachers need to be personally interested in science themselves, as this will foster the students' personal interest, and encourage students to consider careers in science. It is important that the syllabus of Senior Science encourages students to become more interested. Teachers of this subject need to endeavour to create a course that is tailored to the individual students' needs, and the course should be practical, hands-on and highly relevant to their everyday life. Gallagher (1994) supports this as he found that students' perceptions of their teachers' attitudes towards teaching science and towards individual students are predictors of student decisions to persist with science after Year 12.

Research Question Two:

What Aspects of Science Education are Likely to Influence the Career Aspirations of Year 12 Science Students?

General findings

Assertion Four

Many science students did not feel that their science lessons or science teachers encouraged them to pursue science after Year 12.

Fairly low percentages of students recorded that they felt that their science lessons encouraged them to be interested in science after Year 12. Students that studied Human Biology, Biology and Physics felt this to be true more than the Chemistry or Senior Science students. As noted previously, students that undertake TEE courses in the science subjects may have already had an interest in science and already have planned a career in science. It is also very common in Year 12 for students to undertake a TEE science course as it is a requirement for entrance into tertiary courses. Students studying Senior Science may already be planning a career in other areas, and their science lessons may have had little or no impact.

Surprisingly, very low percentages of students recorded that they felt their science teachers encouraged student interest in a career in science. This was in sharp contrast to the very high ratings recorded by students who felt that their teachers were interested in their science subject and made it relevant to every day life. Biology and Chemistry students felt that they had been encouraged the most towards careers in science, but this was still only 26% of the cohort of students studying both of these subjects. Human Biology, whilst seeming to be the most favourable subject in this data collected, only reported 14% of students feeling that they had been encouraged

towards a career in science. Senior Science only had 7% of students feeling that they had been encouraged by their science teachers towards a career involving science. This could be due to many factors, such as teachers not feeling that they have enough time to delve into careers in science during their lessons due to syllabus constraints and lack of time to deliver core material. Science teachers, when interviewed, did comment that they liked to talk about careers in science, but felt that they often did not have the expertise or experience to be fully informed. They very often would forward the students to the careers counselors who had all the updated information. There were other science teachers that did see themselves as an integral part of helping to guide students towards informed choices for their careers. During the focus group interviews, students indicated that they did appreciate information from science teachers, and found it helpful when making decisions.

Assertion Five

Many Year 12 science students have explored career paths in science for after completion of Year 12.

When asked if they had explored career paths in science, just under half of the Biology and Human Biology students reported that they had explored careers in science. About one third of Physics and Chemistry students also reported that they had explored career paths. Only one-fifth of Senior Science students had explored career paths in science. Due to many career paths feeding off the biological sciences, it is not surprising that many students had explored career paths in this area. There are many job opportunities in areas such as the environmental sciences, the health sciences, food sciences and many other related areas. Many students that opt for Physics and Chemistry in Year 12 will have already been channeling themselves towards careers such as medicine, engineering, pharmacy and dentistry which are all considered to be careers in science.

Suggestions for improvement

- There needs to be a concerted effort in science lessons to educate students about the careers that science has to offer. In this formative stage of career development, students need to be given as much information as possible and encouraged to seek information if there is any interest in a particular vocation. Osborne and Collins (2001) comment that it is important that science teachers make clear to students the wide range of occupations in the scientific fields. Teachers must endeavour to raise specific examples to emphasise the value of science qualifications for the wide range of occupations available.
- Science teachers, themselves, need to be informed of the careers availaable in science. Time should be allocated during professional development days to educate science teachers about the vast and changing nature of science and the new and exciting careers that it has to offer. It could also be beneficial to provide teachers with industry placements in science careers so that they become better informed about the range of careers in science. Unfortunately, this may result in some of our best science teachers being recruited by other industries, but could be invaluable is they continue to serve in education.
- Students need to see that their science teachers enjoy science teaching as a career, as this will influence their own disposition towards science as Year 12 students will see it is a positive and rewarding area to be working in. Eichenger (1997) found that the quality of teacher-student interaction impacted very highly on student attitudes towards science. This is further supported by Gallagher (1994) who noted that teacher attitudes towards the teaching of science and towards individual students have a big impact on student attitudes towards science. Teachers must endeavour to maintain the interest of their students in science, as this has been noted by many students as one of the main reasons they choose to continue with a career in science. If students enjoy science in Year 12, they are probably far more likely to consider a future career pathway in science.

Research Question Three:

What Other Significant Factors Influence the Career Aspirations of Year 12 Science Students?

General findings

Assertion Six

Personal interest and academic ability are the two of the most significant factors to influence the career aspirations of Year 12 science students.

The results indicate that personal interest was the most significant factor that influenced the career aspirations of Year 12 science students. As students are exposed to such a vast array of choices for careers, it makes sense that they will pursue a choice that fits in line with their own personal interest. The majority of students that participated in the research seemed to realise that they must be personally interested in their career choice to be able to achieve success, and to feel happy when entering the workforce in their particular chosen area.

Academic ability also was perceived to have a strong influence, and it is evident from the written surveys and focus group interviews that Year 12 students are endeavouring to choose careers that are in line with their academic ability. The students that participated in the research indicated that if they were successful academically in their Year 12 subjects, they would be able to expect reasonable success in a career choice at a tertiary institution that also required mastery of this subject area. Some students expressed that they would be reticent to enter a career pathway involving subjects in which they perceived their academic ability to be poorer.

Assertion Seven

Employment opportunities and salary potential are reasonably significant factors to influence the career aspirations of Year 12 science students.

It can be seen that the opportunities for employment after completing tertiary qualifications remains reasonably influential in the career choices that Year 12 science students make. Whereas salary potential also rates as a reasonably influential factor as well, it seems that it is more important for Year 12 students to have employment at the end of their tertiary life. This is not surprising, given the climate of today's workforce, and the importance of having regular employment and a regular salary.

Assertion Eight

University as a preferred option influences the career aspirations of Year 12 science students.

University as a preferred option was extremely influential with the majority of the Year 12 science students surveyed, whilst TAFE as a preferred option was one of the least significant factors. The Year 12 science students that were surveyed and interviewed did seem to perceive that university was to be deemed to be a successful path, and TAFE was a back-up option for consideration if university entry was unsuccessful. During interviews with the Year 12 science students, science teachers and careers counselors, this was confirmed several times. It must also be recognised, however, that the majority of students that participated in the research were probably university bound as only a small percentage were completing a non-TEE or wholly school based assessed course, and the majority of students were completing a TEE course. The information gathered from university representatives and university expos also was seen to have a reasonable influence on the career aspirations of Year 12

science students. In contrast, information from TAFE representatives was not seen as influential by many of the students, although this could have been due to the relatively small number of non-TEE students that participated in the research.

Assertion Nine

Parental influence is moderately significant in the career aspirations of Year 12 science students.

Parental and family influence was also seen to have a moderate influence on decisions made about what career path students take. There was evidence from the written survey comments and focus interview data that many students were endeavouring to enter a career that their siblings or parents had previously chosen. There also seemed to be indications of a strong parental influence in respect to university entry being favourable, and TAFE being an option which is least desirable.

Careers counselors and science educators both seemed to perceive that parental influences played a major part in the career choices that Year 12 students make. Year 12 students that participated in the focus group interviews did stress that it was their decision in the end, but recognised that parental influence did impact on their choices about career options. It could be that the parental influence is quite subtle, and that students are not entirely aware of the full impact of parental opinions on their own personal choices.

Assertion Ten

A majority of Year 12 science students do not see careers counselors as being significant influences on their personal career aspirations.

The role of careers counselors was seen as not very influential by Year 12 science students making their career choices. This is quite worrying, as from the accounts of the careers counselors from the same school as these students, they see their role as very influential. From interviews with careers counselors, it seems that a lot of focus of their role is in Year 10 where work experience, subject selection and information about careers seems to be paramount. By the time the students reach Year 12, there seems to be less ongoing education about careers and many of the students interviewed perceived that they no longer had much support in Year 12. This could be due to the increased role of careers counselors with students that are actually entering the workforce after Year 12, in contrast to a lesser involvement with students that will be pursuing further tertiary education.

It must be noted, however, that many careers counselors give information about career paths, and are less likely to try to persuade students to enter particular paths. This may have resulted in the lower rating. Students, by the time they have reached Year 12, probably match their interests and abilities to information received about career paths which is normally provided by careers counselors.

Work experience in Year 10 was not seen as very influential either, but it is probably reasonable to assume that the work experience employed in Year 10 may no longer have as much significance for students in Year 12, as they may have made different choices about their chosen career paths.

Suggestions for improvement

- There needs to be a greater promotion of TAFE courses as viable career options. Whilst recognising that university is a preferred option for many of Year 12 students, there must be greater education about TAFE as a viable option for students in this study. As many students struggle to get into university and be successful, it may be that some of these students may experience success in the more competency based courses that are offered at TAFE. Students also need to be educated about the ability to transfer into university from TAFE at a later stage if they are academically able to do so, or if this would be advantageous to their career choice.
- Careers counselors need to have a more active role in Year 12. Whilst this is happening in many of the schools that participated in the research, it seems that it would be advantageous to allocate times where Year 12 students gain information about career choices, university and TAFE options, and counseling as how to make the best personal choices. It seems to be that attendance to many of the talks offered by secondary schools are optional instead of compulsory. A compulsory two weekly information session throughout the year would be very beneficial to the majority of Year 12 students, and perhaps offer the guidance that many of these students seem to need.
- Parental education about viable career choices needs to be increased in the majority of secondary institutions. Year 12 Parent Information evenings should be run at least twice in the academic year to inform parents of viable options for their children. It seems evident that many parents continue to have unreasonable expectations of their children, and they need to be informed of the benefits of all tertiary education and what is going to be best for their children in terms of future success and self esteem. As noted in the literature review by Santos and Coimbra (2000), parents can be very active agents in their role of influence in their children's career aspirations, and thus it is important to educate parents properly about viable post compulsory options for their children.

Conclusion

In summary, it can be noted, that whilst many of our Year 12 science students are reporting high levels of enjoyment of science, there is significant room for improvement based upon this research. For teachers to maintain their students' interest in science, they must endeavour to teach science in a relevant fashion, enabling students to understand and to be able to explain the concepts of science (Goodrum, Hackling & Rennie, 2001; Osborne & Collins, 2001). The rapport between teacher and student seems to be very significant in fostering student's enjoyment of science, and this needs to be highly valued in the teaching process (Osborne & Collins, 2001).

Whilst many students in this study, felt that their teachers were interested in their subject areas, it was noted that they did not feel that they were individually encouraged to pursue science careers after Year 12. The importance of teachers acknowledging the range of careers that requires science should not be underestimated, as there are many occupations that scientific knowledge will support (Osborne & Collins, 2001). To portray science in a real life context is essential and should be integrated into classroom experiences on a regular basis (Committee for the Review of Teaching and Teacher Education, 2003).

It would be useful for TAFE and University bodies to educate secondary teachers about the range of scientific occupations available through some form of professional development. This is, however, probably a low priority for professional development in secondary schools although it would enable teachers to be able to filter this information to secondary students from a scientific point of view which would be invaluable in promoting careers in science.

Whereas it is seen that personal interest and academic ability are significant factors that influence the career aspirations of Year 12 students, it must also be acknowledged that parental expectations also rate reasonably high. It is important that secondary schools include parents in the career education process, as it can be seen that many

parents are having unreasonable expectations of their Year 12 children, and this may be causing Year 12 students to make unsuitable choices for their tertiary education.

The role of careers counselors needs to be seen as more active in Year 12. Whilst all of the schools that participated in the research had excellent programs for career education, many students were not utilising the availability of the career counselors. Therefore, information that the careers counselors can give Year 12 students about university and TAFE courses and general information must be readily accessible.

In conclusion, it is important to note that a greater priority needs to be given to developing the quality of secondary science education. It is very important that all students experience a science education that will make a difference in their lives whilst fostering scientific literacy. It is also important, as a society, to attract our best young minds into science as this will endeavour to increase the competitiveness of the industry of science in Australia (Goodrum, Hackling & Rennie, 2001).

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APPENDICES

APPENDIX A: THE DISCLOSURE STATEMENT AND WRITTEN SURVEY

DISCLOSURE STATEMENT

This is an anonymous questionnaire. Please ensure that you do not write your name, or any other comments that will make you identifiable on the attached. By completing the questionnaire, you are consenting to take part in this research. As such, you should first read the following Disclosure Statement carefully as it explains fully the intention of this project.

The research being undertaken is to investigate the factors that influence the career aspirations of Year 12 science students.

Five metropolitan secondary high schools will be investigated, and all Year 12 science students will participate in an attitude survey. This is an anonymous survey and participants and specific schools will not be identified. Schools will be identified as School 1-5.

Any quotes used in the research will not have individual students being identified.

This research will aid to identify the individual, social and environmental influences that influence the career aspirations of Year 12 science students. Science learning experiences also will be examined to see if they have an impact on an individual's desire to continue to study science past secondary school.

The survey should take approximately 15 minutes to completed, and will be carried out in class time and delivered by the respective science teachers. If you do not wish to participate in the survey, please inform the teacher who is distributing the survey in class.

Any questions or concerns about the project entitled " Factors that influence the career aspirations of Year 12 science students" can be directed to Christina Soames of Edith Cowan University on [redacted]

If you have any concerns about the project or would like to talk to an independent person, please feel free to contact Dr Vaille Dawson at Edith Cowan University on 9370 6476.

Thank you

Christina Soames
Science Education
Edith Cowan University

"This is an anonymous questionnaire. Please ensure that you do not write your name, or any other comments that will make you identifiable, on the attached. By completing the questionnaire you are consenting to take part in this research. As such you should first read the enclosed Disclosure Statement carefully as it explains fully the intention of this project."

SURVEY ON INFLUENCES OF SCIENCE ON CAREER ASPIRATIONS

Thank you very much for completing this survey. As a Year 12 student, you only need to participate in this survey ONCE. If you are completing it for the second time, please notify the teacher distributing the survey and do not continue.

Please circle your correct response.

If there is a need for a written response, please write clearly.

Sex: 1 Male 2 Female (Please circle the correct sex)

1. What Science subjects do you study in Year 12?
Please circle your subjects that you study.

1 Physics 2 Chemistry 3 Physical Science

4 Biology 5 Human Biology 6 Senior Science

2. Please rate the following statements according to your experiences in each of the particular course of Science that you study in Year 12.

1 = Almost never
2 = Sometimes
3 = Often
4 = Very often
5 = Always

If you study more than two science subjects, just fill out for your two of preference.

SCIENCE SUBJECT ONE: _____

Please list first science subject studied in Year 12, and answer questions in reference to this particular subject

YOUR EXPERIENCES OF THIS PARTICULAR COURSE OF SCIENCE IN YEAR 12 Subject: _____(list)	**What is true for me in this science subject?** Never	Sometimes	Often	Very often	Always
My learning in this science subject will be relevant to my future	**1**	**2**	**3**	**4**	**5**
My science teacher explains the relevance of topics we learn to every day life	**1**	**2**	**3**	**4**	**5**
This subject of science deals with topics that I am concerned with	**1**	**2**	**3**	**4**	**5**
My science lessons in this subject have encouraged me to be interested in careers in Science after Yr 12	**1**	**2**	**3**	**4**	**5**

YOUR EXPERIENCES OF THIS PARTICULAR COURSE OF SCIENCE IN YEAR 12	What is true for me in this science subject?				
	Never	Sometimes	Often	Very often	Always
My science teacher has encouraged my interest in a career in science	1	2	3	4	5
I enjoy being able to understand and explain the concepts of science in this subject	1	2	3	4	5
I find that science requires me to have to memorise a lot of information in this subject.	1	2	3	4	5
I find the practical work in science interesting and relevant in this subject	1	2	3	4	5
I am curious about this area of science	1	2	3	4	5
I have explored career paths in this area of science	1	2	3	4	5
I am never bored with this science subject	1	2	3	4	5
I find my teacher to be interested in this science subject.	1	2	3	4	5

In what way, if any, have your science experiences in this subject in Year 12 influenced your career aspirations?

_____

_____

_____

_____

_____

SCIENCE SUBJECT TWO: _____

Please list second science subject studied in Year 12, and answer questions in reference to this particular subject

YOUR EXPERIENCES OF THIS PARTICULAR COURSE OF SCIENCE IN YEAR 12 Subject: _____(list)	What is true for me in this science subject?				
	Never	Sometimes	Often	Very often	Always
My learning in this science subject will be relevant to my future	1	2	3	4	5
My science teacher explains the relevance of topics we learn to every day life	1	2	3	4	5
This subject of science deals with topics that I am concerned with	1	2	3	4	5
My science lessons in this subject have encouraged me to be interested in careers in Science after Year 12	1	2	3	4	5
My science teacher has encouraged my interest in a career in science	1	2	3	4	5
I enjoy being able to understand and explain the concepts of science in this subject	1	2	3	4	5
I find that science requires me to have to memorise a lot of information in this subject.	1	2	3	4	5
I find the practical work in science interesting and relevant in this subject	1	2	3	4	5
I am curious about this area of science	1	2	3	4	5

YOUR EXPERIENCES OF THIS PARTICULAR COURSE OF SCIENCE IN YEAR 12 Subject: _____(list)	What is true for me in this science subject?				
	Never	Sometimes	Often	Very often	Always
I have explored career paths in this area of science	1	2	3	4	5
I am never bored with this science subject	1	2	3	4	5
I find my teacher to be interested in this science subject.	1	2	3	4	5

In what way, if any, have your science experiences in this subject in Year 12 influenced your career aspirations?

_____

_____

_____

_____

_____

3 Do you intend to go on to further study after the completion of Year 12?

1 Yes (go to Question 4) 2 No (see below)

If No, what do you plan to do next year? (go to Question 5)

_____

_____

_____

4. If you are planning on a course for tertiary study, what are your areas of interest. (eg. Medicine at UWA, Nursing at TAFE, Early Childhood teaching at ECU, Commerce at Murdoch.

You may describe three areas, but please rank in order of interest

1.
2.
3.

5. Please rate the following influences as to how they have affected your career choices for after the completion of Year 12.

1 = Not influential
2 = Slightly influential
3 = Moderately influential
4 = Very influential
5 = Extremely influential
N/A = Not applicable

INFLUENCES ON POSSIBLE CAREER CHOICES	How these influences have affected your career choices					
	Not Influential	Slightly influential	Moderately influential	Very influential	Extremely influential	Not applic
Parental expectations	1	2	3	4	5	N/A
University as a preferred option	1	2	3	4	5	N/A
TAFE as a preferred option	1	2	3	4	5	N/A
Work experience	1	2	3	4	5	N/A
Peers	1	2	3	4	5	N/A
Career education	1	2	3	4	5	N/A
Academic ability	1	2	3	4	5	N/A
Personal interest	1	2	3	4	5	N/A
Employment opportunities	1	2	3	4	5	N/A
Prestige in society/ salary potential	1	2	3	4	5	N/A
My experiences in science	1	2	3	4	5	N/A
Media/ TV/ newspaper influence	1	2	3	4	5	N/A
Teacher expectations	1	2	3	4	5	N/A
Teacher role models	1	2	3	4	5	N/A
Advice of careers counselors	1	2	3	4	5	N/A
University information from Universities/ expos	1	2	3	4	5	N/A
TAFE information	1	2	3	4	5	N/A

Please list any other influences that have not been listed, but have impacted on your career choices for after completion of Year 12. You may also wish to clarify any of your responses to the choices above.

_____
_____
_____
_____
_____
_____
_____
_____
_____

THANK YOU VERY MUCH FOR CONTRIBUTING TO THE RESEARCH BY COMPLETING THIS SURVEY.

APPENDIX B: CONSENT FORM FOR STUDENTS, TEACHERS AND CAREERS COUNSELORS

Dear Parent/ Guardian

RE: MASTERS RESEARCH PROJECT TITLE
Investigating the factors that influence the career aspirations of Year 12 science students

The research that I will be undertaking is to investigate the factors that influence the career aspirations of Year 12 science students. Six students have been chosen by their respective science teachers to participate in a focus group interview that will be further investigating their thoughts about science and their future career aspirations. These interviews will be recorded by tape and transcribed for further analysis. The tapes will be transcribed for data that will be used in the study, although all views will remain strictly anonymous. It is expected that the interviews should take no longer than 30 minutes and will be timed to be of least inconvenience to students.

Five metropolitan secondary high schools will be participating in the research project with all Year 12 science students in each secondary school participating in an attitude survey. This is also an anonymous survey, and participants and specific schools will not be identified. Any quotes used in the research will not have individual students being identified.

This research will aim to identify the individual, social and environmental influences that influence the career aspirations of Year 12 science students, and will be useful to educators involved in science and those school personnel involved in advising students of career pathways. Science learning experiences also will be examined to see if they have an impact on an individual's desire to continue to study science past secondary school.

If you agree to participate in the interview, it will be of much benefit to the research project and invaluable to science educators at your respective secondary institution.

If you have any concerns or questions about the project please do not hesitate to contact Christina Holly at Edith Cowan University on [redacted] If you would like to speak to an independent person in respect to the project, feel free to contact Dr Max Angus at Edith Cowan University on 9370 6492.

If you agree to take part in the Project, please complete the sheet below and return to the Head of Science at your respective secondary school as soon as possible.

Yours sincerely

[redacted]

Christina Holly
Science Education
Edith Cowan University

Please return the following slip as soon as possible to the Head of Science/ or other teacher that is nominated.

I, _____ (student's full name) have read the information above and any questions that I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time. I agree that the research data gathered for this study may be published provided that I am not identifiable.

I understand that I will be interviewed and the interview will be audio recorded. These tapes will be locked in a filing cabinet and will not be available for any other use other than the research project. I also understand that the recording will be erased once the interview is transcribed.

Student:_____ Date: _____

If your son/ daughter would participate in the interview, and if you are agreeable to his/her participation, please sign below.

Parent/ Guardian: _____ Date: _____

To Whom It May Concern

RE: MASTERS RESEARCH PROJECT TITLE
Investigating the factors that influence the career aspirations of Year 12 science students

The research that I will be undertaking is to investigate the factors that influence the career aspirations of Year 12 science students. I will be interviewing two science teachers from each school, careers counselor and Year 12 Coordinator if possible. These interviews will be recorded by tape and transcribed for further analysis. The tapes will be transcribed for data that will be used in the study, although all views will remain strictly anonymous. It is expected that the interviews should take no longer than 30 minutes and will be timed to be of least inconvenience to school personnel.

Five metropolitan secondary high schools will be participating in the research project with all Year 12 science students in each secondary school participating in an attitude survey. This is also an anonymous survey, and participants and specific schools will not be identified. Any quotes used in the research will not have individual students being identified.

This research will aim to identify the individual, social and environmental influences that influence the career aspirations of Year 12 science students, and will be useful to educators involved in science and those school personnel involved in advising students of career pathways. It will be useful to have the thoughts and views of science educators, careers counselors and the Year 12 Coordinator as they will also have identified some factors that further influence career aspirations of science students. Science learning experiences also will be examined to see if they have an impact on an individual's desire to continue to study science past secondary school.

If you agree to participate in the interview, it will be of much benefit to the research project and invaluable to science educators at your respective secondary institution.

If you have any concerns or questions about the project, please do not hesitate to contact Christina Holly at Edith Cowan University on [redacted] If you would like to speak to an independent person in respect to the project, feel free to contact Dr Max Angus at Edith Cowan University on 9370 6492.

If you agree to take part in the Project, please complete the sheet below and return to Christina Holly at the beginning of the interview.

Yours sincerely

[redacted]

Christina Holly
Science Education
Edith Cowan University
Mount Lawley Campus

Please return the following slip to Christina Holly at the beginning of the interview

I, _____ (teacher/ counselor's full name) have read the information above and any questions that I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time. I agree that the research data gathered for this study may be published provided that I am not identifiable.

I understand that I will be interviewed and the interview will be audio recorded. These tapes will be locked in a filing cabinet and will not be available for any other use other than the research project. I also understand that the recording will be erased once the interview is transcribed.

Teacher/ counselor:_____ Date: _____

APPENDIX C: PERMISSION LETTERS SENT TO PRINCIPALS AND HEADS OF SCIENCE

Date

Principal
School
Address

Dear ....*Principal*...

I am writing to request your permission for ...*school*....Girls to participate in a research project that is investigating the influences that affect the career aspirations of Year 12 science students.

I am currently completing my Masters research thesis at Edith Cowan University whilst working at Edith Cowan University in the area of primary science education. I am a trained secondary science teacher, and have worked at Penrhos College as a science teacher and Year 12 Coordinator for the previous eight years.

I have already spoken to ...*Head of Department*...in regards to the project, and her staff are willing to participate in the project with your approval.

The research involves all Year 12 science students (Senior Science, Biology, Human Biology, Chemistry and Physics) completing an attitude survey which will take approximately 10 minutes. It includes some quantitative questions (tick box – select response) and two open-ended qualitative questions. This attitude survey relates to attitudes, knowledge and experiences of science and also some questions about career aspirations.

This is an anonymous survey, therefore will not need written consent from parents, although each survey will have the disclosure statement attached to it. I have attached this also for your perusal. The project has been cleared by the Ethics Committee at Edith Cowan University.

The survey distribution will be distributed to classes with correct numbers for the different science subjects for easy distribution to classes.

I also wish to interview six students from the school which will be of approximately 30 minutes duration. I wish to do this in two groups of three students. One group will be comprised students studying Senior Science, Human Biology or Biology, and the other group will have three students that are enrolled in Physics or Chemistry. These students would be selected by the Head of Science as I wish to interview students of

varying academic ability. Parental consent will be required for these interviews, and I will organise the consent forms with ....*Head of Department*...
I will endeavour to have surveys and interviews with students all completed by September, as I am aware that time constraints and student stress may be paramount, leading up to the Mock exams in Term Three.

I also want to briefly interview two science teachers, the Careers Counselor and the Year 12 Coordinator if they are involved in career information to the Year 12 students. These are only expected to be of 10-15 minutes duration, as I am aware that staff are very busy in the school environment.

Where the results of this study are published, all interviewees, students and staff, will remain anonymous, and also the school will be represented as "School A" or another similar coding method. The school will also receive a summary of data and findings collected

If you would like to contact me regarding any of the above, or the information that follows, my contact details are [redacted]

Yours sincerely

[redacted]

Christina Holly
Faculty of Community Services,
Education and Social Sciences
Edith Cowan University

Date

Name
Head of Science
Address

Dear... *Head of Science*

I am writing to confirm your verbal agreement for ...*school*....to participate in a research project that will investigate the influences that affect the career aspirations of Year 12 science students. The research data collected will contribute to my Masters Research Thesis to be completed by September 2004.

I have sent correspondence to ...*the Principal*... about the project, confirming that you have expressed willingness to participate in the research.

I wish to interview six students from the school which will be of approximately 30 minutes duration. I wish to do this in two groups of three students, and would like to complete this early Term Three. One group will be comprised of the Senior Science, Human Biology and Biology student, and the other group will have three students that are enrolled in Physics or Chemistry. These students would be selected by your self, if possible, as I wish to interview students of average academic ability. These students will have to have the consent of their parents, and I will organise a letter to be sent out for the students to return to school before the time of the interview (A copy of the proposed letter is attached).

All Year 12 science students (Senior Science, Biology, Human Biology, Chemistry and Physics) will also be required to complete an attitude survey which will take approximately 10 minutes. It includes some quantitative questions (tick box – select response) and two open-ended qualitative questions. This attitude survey relates to attitudes, knowledge and experiences of science and also some questions about career aspirations. I am anticipating that this survey will be given to students in early September, once they have received TISC/TAFE forms. This survey will be photocopied with class numbers for easy distribution, and probably would be best delivered at the end of a teaching lesson for the teacher's convenience.

The survey is anonymous and therefore will not require written consent from parents, although each survey will have the disclosure statement attached to it. I have attached this also for your perusal. The project has been cleared by the Ethics Committee at Edith Cowan University.

I will endeavour to have interviews and surveys with the students completed by mid September, as I am aware that time constraints and student stress may be paramount, leading up to the Mock exams in Term Three.

I also want to briefly interview two science teachers, the Careers Counselor and the Year 12 Coordinator if they are involved in career information to the Year 12 students. These are only expected to be of 10-15 minutes duration, as I am aware that staff are very busy at this time of the year.

All interviewees, students and staff, will remain anonymous, and also the school will be represented as "School A" or another similar coding method. The school will receive information regarding the data collected and findings in the written report, and I anticipate that this will be useful for the school itself.

If you would like to contact me regarding any of the above, or the information that follows, my contact details are [redacted]

Yours sincerely

[redacted]

Christina Holly

Faculty of Community Services,
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